AUGUST, 1928

25 CENTS

RADIO

(REG. U. S. PATENT OFF.)

MAGNAVOX *Dynamic* SPEAKERS

Aristocrat Model

Beautiful butt burl walnut cabinet finished in two tones.
For A-Battery Operation . $70
For AC Operation $85

Beverly Model

Gracefully proportioned cabinet finished in light mahogany.
For A-Battery Operation . . . $55
For AC Operation $70

Other floor and table models up to $175.
Units only; DC $35; AC $50.

"FIRST SPEAKER FIRST DYNAMIC"

Dynamic realism is radio's newly acknowledged refinement . . . originally sponsored by Magnavox. Every tone rich, full and vivid . . . over entire audible range. A cascade of volume . . . without distortion. America's finest radio sets are made with Magnavox Speakers as built-in equipment.

THE MAGNAVOX COMPANY

Oakland, California Chicago, Illinois

FADA Radio

THE FADA—30

An A.C. Electric Radio with Cabinet and Speaker

$197.50

Slightly Less East of the Rockies

Pride of Possession

Pride of possession is experienced by all owners of Fada Radios.

Fadas are built up to a standard—not down to a price. They do more than receive. They deliver—and how.

The new Fada Radios include all that is at present known in the development of a perfect radio receiver and will out-distance, out-quality, and out-perform any other set at or near the price.

You may *pay more* and get no better radio results, but you will *miss more* by paying less.

It is this combination of dollar for dollar value with the utmost in radio results which makes each Fada buyer proud to say, "I own a Fada."

F. A. D. ANDREA, Inc.

Jackson Avenue, Orchard and Queens Streets
LONG ISLAND CITY, N. Y.

CHICAGO KANSAS CITY SAN FRANCISCO

RADIO

Established 1917

Published Monthly by the Pacific Radio Publishing Co.

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FORECAST FOR SEPTEMBER ISSUE

John P. Arnold continues his radio picture department with a study of two methods of latent image reception and a discussion of the necessity for standardizing still picture transmission. G. M. Best describes the construction of a two-tube short wave receiver with shield-grid tubes and recounts the evolution of the vacuum tube. Francis Churchill details the construction of a broadcast receiver using a plate resistor circuit. Wm. E. Bostwick tells how to make an inexpensive electro-dynamic cone loudspeaker at home. S. R. Winters quotes Dr. L. W. Austin's ideas on radio-wave propagation. Harry R. Lubcke describes the construction and operation of a vacuum tube voltmeter having a 0-500 volt range. George T. Conner discusses flying radio. A. Binneweg, Jr., shows how he accomplishes 5-meter reception. G. E. West describes the construction of his 80-meter amateur phone and C. W. transmitter. R. Wm. Tanner has an interesting story on a 20-meter amateur phone. The fiction feature is a radio police story, "The Dancing Green Lights," by Earle Ennis.

Effective Immediately

"RADIO" guarantees *all advertising in its pages*

THE Federal Trade Commission at Washington has called a conference to induce publishers to shoulder legal responsibility for any misleading advertisements in their publications. If the Commission succeeds in this praiseworthy purpose investigators would have to be maintained by every publisher to check up on every advertisement submitted. Many publishers feel that the responsibility for misleading ads should be borne by the advertiser because the average publisher tries to keep his pages as clean and free from deception as possible.

Although "RADIO" has not yet been officially notified to have its representative appear before the Commission, the publishers wish to announce that they willingly assume the responsibility for any misleading statements that may appear in its advertising columns. "RADIO" has always censored its advertising and now goes one step further to guarantee the truthfulness of every statement in its pages. All claims made by advertisers in "RADIO" are verified before their copy is accepted and if any buyer proves that goods purchased are not as represented, the publishers stand ready to refund his money upon return of equipment for which the advertiser will not make good.

Pacific Radio Publishing Co.

Established 1917

SAN FRANCISCO
NEW YORK
CHICAGO
BOSTON

Tell them you saw it in RADIO

In 1926 it was Power Tubes
In 1927 it was A. C. Circuits
In 1928 it *is* the Dynamic Speaker!

Dominating this Year's Radio Exposition s - - -

and representing the real big development of the 1928 Season—the Dynamic Speaker has proved itself the focal point of all the 1928 Shows.

Leading radio trade publications, seeking the "live" stories, are featuring the Dynamic Principle.

The Radio Public—graduated to a realization of tone and harmony possibilities—is enthusiastically buying the Dynamic Speaker.

The JENSEN MANUFACTURING COMPANY point with pride to their part in this major development. They feel that the Jensen Dynamic Speaker—built with utmost care by hand—and backed by the nationally recognized inventive genius of Peter L. Jensen—is the outstanding Radio Speaker of the year . . . that is why every Jensen Dynamic Speaker is so carefully manufactured to be "The Finest in Radio."

Jensen Cabinet Speakers—for D.C. and A.C. operation—from $55.00 to $70.00. Jensen Dynamic Units—for radio and phonograph cabinet installation—$40.00 and $43.00.

JENSEN RADIO MANUFACTURING CO.

212 Ninth Street, Oakland **338 North Kedzie Avenue, Chicago**

You are cordially invited to visit the Jensen Booth at the Pacific Radio Exposition. The complete Jensen line will be on display and the principle fully explained by a competent engineer.

JENSEN
DYNAMIC·SPEAKER

"The Finest in Radio"

A special two-color folder describes the complete line of Jensen Dynamic Speakers. Write for a copy.

Licensed under Magnavox Patents

What Others Say

Salt Lake City, Utah.
Oct. 13, 1927.

My Bremer-Tully Receiver has given entire satisfaction and I am of the opinion that I have just a little better outfit than the other fellow.

It has been my experience to bring in stations within a radius of 2,000 miles. This is considered very good in this locality.

C. P.

Ft. Worth, Tex.
Dec. 27, 1927.

I know nothing about radio other than to state that the Bremer-Tully which I purchased in 1925 is still the best I ever saw. I am using the same tubes that came with it, and getting results.

Livingston, Mont.
Dec. 23, 1927.

Out here in Montana far away from broadcasting stations, we have to have a good radio to bring them in. Although I have heard many I never heard one that I could say I wanted until my friend brought me down to hear his Bremer-Tully. I now have one like it and have been able to get the best kind of reception every night and everybody says it is the best set they have ever heard.

J. V.

The 6-40 is furnished in two cabinet styles—Model "R" illustrated at the top of the page and Model "S" illustrated above. Both are of equal size.

Bremer-Tully

RADIO

SINCE the earliest days of commercial broadcasting every Bremer-Tully radio product has been a continued outstanding success.

Six years of progress—and a reputation second to none—Bremer-Tully start their seventh season with the finest receiver in its class, the new 6-40.

It is the culmination of these years of experience, the result of many months' intensive effort and development.

Simple, compact, self-contained, the 6-40 embodies all those features and refinements that are responsible for the traditionally fine Bremer-Tully quality—and at the amazingly low price of $136.00.

A radio set that surpasses everything at anywhere near its price in musical reproduction—a set that excels in general performance as well.

See it, hear it, compare it—you will be convinced that here is the greatest radio value ever offered.

The coupon will bring descriptive literature and name of our dealer in your community.

Bremer-Tully Mfg. Company

520-532 SO. CANAL ST., CHICAGO

Name.....

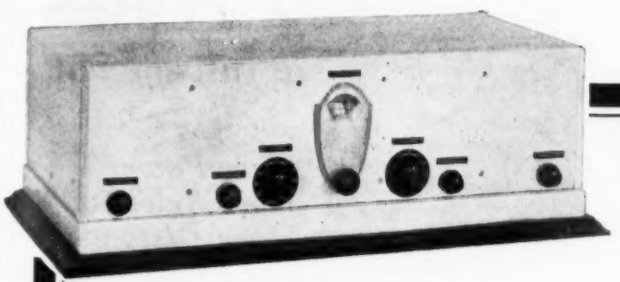
Address.....

City.....*State*.....

SM

Ready—THE 710

SARGENT-RAYMENT SEVEN



A STATION tuned in for every ten kilocycles—an average of one hundred stations heard in one evening—that is the performance record of the Sargent-Rayment Seven, tested in the heart of Chicago interference on a warm summer evening. To the ultra-skeptical veteran listener we heartily recommend this peer of all receivers. In performance, as in unique appearance, it is a precision laboratory type of instrument, intended for the man who desires the very extreme of radio reception in all respects, irrespective of cost or other limitations. The results it gives place the Sargent-Rayment Seven as leader even among "stunt" sets; but one hearing of its fine tone will remove it entirely from the limitations of any such classification—it is, truly, the set of sets.

It is unnecessary to introduce Messrs. Sargent and Rayment, whose invention of a unique receiver system has made them well known to every radio fan. Their new receiver, developed in conjunction with the Silver-Marshall engineering laboratories, needs no other recommendation than the names of its designers, and the full and complete endorsement of Silver-Marshall.

The 710 Sargent-Rayment Seven is a precision laboratory radio receiver. It has been designed throughout as such. It is like a battleship stripped for action, shorn of every piece of surplus gear. The thick aluminum shielding and chassis, finished in satin silver and trimmed by black instrument name plates with white engraving, gives to the appearance a beauty and dignity in keeping with the set's fine performance. Electrically, the receiver consists of five sharply tuned circuits in a four stage screen grid R.F. amplifier, all tuned by a single illuminated drum, and provided with individual verniers. One knob turns the set on and off, and adjusts battery voltage; a second controls volume from zero to maximum, a third regulates antenna selectivity. There are no other controls. Following the R.F. amplifier are the detector and the A.F. amplifiers, using the famous S-M audio transformers which provide unequalled tone quality and high volume. Each circuit is individually shielded, bypassed, and isolated from all others. The set goes together simply and positively, with clear direct wiring. It is a joy to build, so workmanlike is its design and layout.

To the fan who appreciates and values really fine performance, in a truly precision receiver of great individuality and distinction, we unhesitatingly recommend the 710 Sargent-Rayment Seven. The kit for this receiver, approved by the designers and exclusively manufactured by Silver-Marshall, Inc., is priced at $120.00 complete with cabinet.

All S-M distributors are being supplied as rapidly as possible with the Approved Sargent-Rayment kit, but since speed of production is necessarily limited by the extreme precision required in every part of this unique receiver, orders should be placed at once by those desiring to be early on the ground with the Sargent-Rayment Seven.

Exclusive Distributors West of the Rockies
RADIO CONSTRUCTORS CORPORATION
357 12th Street, *Oakland, Calif.*

SILVER-MARSHALL, INC.

852 West Jackson Blvd.
CHICAGO, U. S. A.

A complete booklet written by Messrs. Sargent and Rayment, aided by the S-M engineering staff, is in preparation. It describes the design, construction, operation and maintenance of the Sargent-Rayment Seven. It contains an ample number of large, clear plates, diagrams, and working drawings illustrating every angle of the set, as well as amplification and selectivity charts. It is a treatise of such a generally informative nature as to be a liberal education in precision receiver design.

It will be mailed on receipt of 50c in stamps as soon as off the press.

To SILVER-MARSHALL, INC., 852 Jackson Blvd., *Chicago*
--or, if reader is west of the Rocky Mountains,
To RADIO CONSTRUCTORS CORPORATION, 357 12th St., *Oakland, Calif.*

Please send me booklet on the Sargent-Rayment Seven, as soon as available, for which I enclose 50c.

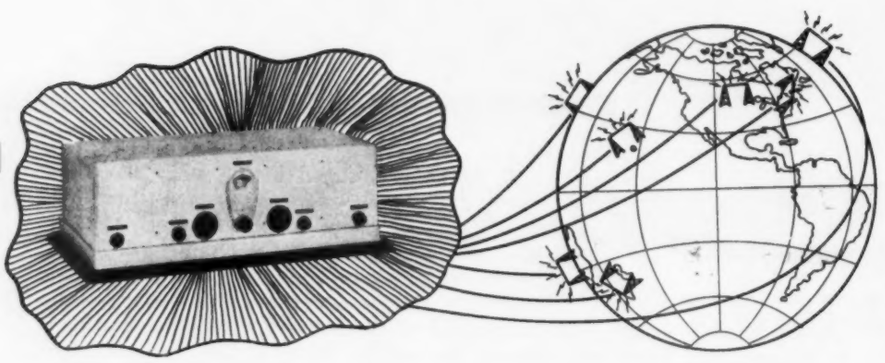
*Name*_____

*Address*_____

*City*_____ *State*_____

Sargent-Rayment Seven

Designed for the discriminating radio owner,—the one who likes radio entertainment that is not necessarily confined to local reception



7 TUBES
at full efficiency

More Power
More Selectivity
More Distance
Than Ever Before
Available in a
Radio Set

A Special Message to Long Distance Fans

The Sargent-Rayment Seven has been designed especially to meet the requirements of the most exacting long distance fan. Although the set is of the single control type, all compensating adjustments have been put on the panel where they are readily available for fine tuning when wanted.

The set uses four of the new screen grid tubes in the radio frequency amplifier. All circuit feedbacks have been eliminated so that the operation is remarkably stable and the efficiency high all over the wave band. There is just as much power and pep up on 500 meters as there is on 300.

Selectivity is today the most important feature of a radio. The ether is so congested with stations that only the set that has razor-edged selectivity can pick out the broadcasters one at a time. Selectivity of the Sargent-Rayment Seven was therefore given first consideration by the designers, and it was definitely determined at the outset that in order to cope with present day conditions a set must have ten kilocycle selectivity and the set was designed accordingly. That it was possible to do this with only seven tubes is a tribute to the efficiency of the circuit, coils, condensers and tubes used, and to the care with which the entire circuit was laid out. Stations come in at only one point on the dial. There are no repeat points, no harmonics, and each station cuts in and out sharply as its wave channel is reached and passed. There is no "spread" of a local station over several degrees to each side of its tuning point. Except that it is louder, a local cuts in and out just like a distant station.

There is a pleasant surprise awaiting you when you tune the dial of your Sargent-Rayment Seven.

Power Supply

The Sargent-Rayment Seven requires a six volt "A" supply. This may be obtained from a good storage battery, or if "all-electric" operation is preferred, an "A" eliminator may be used to plug in the light line and operate the set right from the house lighting current.

Any good "B" eliminator will work satisfactorily on the Sargent-Rayment Seven. 135 to 180 volts are required.

Write for Free Descriptive Booklet

The limited amount of space in this ad does not permit us to go into details about the new features of this circuit. We have therefore prepared a special 16 page descriptive booklet,—"RADIO PAR EXCELLENCE—1929"—which tells about the Sargent-Rayment Seven from start to finish. This booklet, written in plain, understandable language, explains the design of the receiver and shows conclusively just why we are able to make such wide claims for distance, selectivity and tone on the Sargent-Rayment Seven. We would appreciate the opportunity to mail you a copy. Just send in your name and address.

ADVERTISER'S NOTE—In July RADIO this circuit was erroneously listed as a six tube receiver. The first production model had only six tubes and all results listed in July RADIO were obtained with it. The amplification per stage was so high that we thought it best to work the tubes at a lesser strain and consequently added a tube for the sake of more flexible operation. This change was made too late to catch the copy which had already gone to press.

You Can Buy It In Kit Form or BUILT-UP!

Realizing that a great many radio fans prefer to take advantage of established laboratory facilities rather than to attempt to build their own sets, Radio Constructors Corporation has made arrangements to furnish the Sargent-Rayment Seven completely built up, wired, balanced, and tested on distance. This service was inaugurated last year on the Infradyne and proved so popular that special facilities have been installed to take care of the expected demand for the completely built Sargent-Rayment Seven.

All of this work is done by experts, trained for years in the assembly and wiring of radio receivers. All power supply leads, including filament and "B" are neatly cabled together as shown in the illustration on Page 9. Radio frequency wires to grid and plate are kept well in the clear of the shielding. Each part that goes into the assembly is first submitted to a critical inspection, so that none except electrically and mechanically perfect parts are used.

After the assembly and wiring have been finished, the receiver is placed on the laboratory test bench where an oscillating, self-heterodyning wave meter is used to check the high and low wave settings. The radio frequency stages are then balanced to each other, after which tone quality and operation on both batteries are eliminators are checked. After these tests have been successfully passed, the receiver is held over for a night-time test on actual distance reception.

Radio dealers and professional set builders are particularly invited to take advantage of this service. Have your first kit built up and tested here—then if you wish to build your own thereafter, use the first one as a model to work from. Dealers desiring a model for window display and not having time to build it, can thus buy it complete. The service is especially valuable for filling rush orders, as the completely built-up Sargent-Rayment Seven will be available to the trade for immediate delivery.

This special construction service is available to the entire radio trade, including jobbers, dealers, and professional set builders. Dealers and professional set builders may order the completely built up set from their local jobbers who in turn can obtain it here. Sets built up by the Radio Constructors Corporation may be identified by the rubber stamping on the bottom side of the chassis.

PRICES

For the Complete Kit

$120.00

The SM-710 Sargent-Rayment Seven Kit is complete in every respect. All parts are inspected at the Silver-Marshall factory for both electrical and mechanical defects and are fully guaranteed by both Silver-Marshall and by Radio Constructors Corporation to be in first-class condition. Everything is carefully packed to withstand shipment. Complete instructions for assembling and wiring the kit are included. These instructions are so explicit and so well illustrated that the novice will have no difficulty in following them.

All hardware, screws, nuts, washers, brackets—everything necessary to build the set—is included. There is nothing additional to be bought. The kit includes even the "cabinet."

For the Built-Up Set

$150.00

The completely built, wired, and tested Sargent-Rayment Seven receiver is carefully packed in a specially cushioned packing case. It exceeds the parcel post size limits and hence must be shipped by express. Full instructions for connecting the set to the power supply and operating it are included.

IMMEDIATE DELIVERY

Commencing August 1st, we will be able to make immediate delivery throughout the season on either the kit or the built-up set. Orders will be filled the same day as received. Special attention paid to telegraphic orders.

Exclusive Distributors to the Trade West of the Rockies

Radio Constructors Corporation

357 Twelfth Street — Oakland, Calif.

Dealers--

These jobbers can supply you with either the kit or built-up set

Washington

Harper-Meggee, Inc., South 214 Howard St., Spokane, Wash.
Harper-Meggee, Inc., 4th at Blanchard St., Seattle, Wash.
Inland Radio Co., 922 West First, Spokane, Wash.
Fobes Supply Co., Spokane, Wash.
Love Electric Co., 732 Pacific Ave., Tacoma, Wash.
The Wedel Co., 520 Second Ave., Seattle, Wash.

Oregon

Stubbs Electric Co., 75 6th St., Portland, Ore.
Universal Specialties Co., 40 N. Ninth St., Portland, Ore.

Southern California

Herbert H. Horn Co., 1629 S. Hill St., Los Angeles, Calif.
C. C. Lawton, 1125 Wall St., Los Angeles, Calif.
Pacific Wholesale Radio, Inc., 433 East 12th St., Los Angeles, Calif.
Radio Supply Co., 912 S. Broadway, Los Angeles, Calif.
Radio Mfrs. Supply Co., 1000 S. Broadway, Los Angeles, Calif.
Yale Radio Electric Co., 1111 Wall St., Los Angeles, Calif.
Independent Electrical Co., 928 7th St., San Diego, Calif.
Modern Electric Co., 308 West Center St., Anaheim, Calif.
Sunset Electric Co., 1141 1st St., San Diego, Calif.
Williams and Klentz, 409 5th St., Santa Ana, Calif.

Northern California

Electric Supply Co., 370 11th St., Oakland, Calif.
Frederick H. Thompson Co., 1131 Mission St., San Francisco, Calif.
Gilson Elec. Supply Co., 1106 Madison St., Oakland, Calif.
Pacific Radio Sales Co., 357 Twelfth St., Oakland, Calif.
Kimball-Upson Co., 607 K St., Sacramento, Calif.
Offenbach Electric Co., 1452 Market St., San Francisco, Calif.
Coast Radio Supply Co., 648 Howard St., San Francisco, Calif.
United Radio Supplies Co., 1062 Howard St., San Francisco, Calif.

Colorado

Vreeland Radio Corp., 1435 Wilton St., Denver, Colo.
Rocky Mountain Radio Corp., 1512 Broadway, Denver, Colo.
Reynolds Radio and Music Co., 1534 Glenarm St., Denver, Colo.

Arizona

Nielsen Radio Supply Co., 311 N. Central Ave., Phoenix, Ariz.

New Mexico

Packard Service Station, 417 West Gold Ave., Albuquerque, N. M.

Utah

Intermountain Electric Co., 43 East 4th South, Salt Lake City, Utah
Radio Hardware Co., Inc., 342 South State St., Salt Lake City, Utah

Idaho

Oakley and Sons, 11th and Idaho Sts., Boise, Idaho
Rupert Electric Co., Rupert, Idaho

Nevada

Reno Motor Supply Co., Reno, Nevada

Montana

Radio Auto Supply Co., 109 4th Ave., Havre, Mont.

Dealers—Set Builders

Get established now in your community as headquarters for the Sargent-Rayment Seven. Fill in the attached coupon and send it to us for full information.

Radio Constructors Corporation,
357 Twelfth Street,
Oakland, Calif.

Please send me at once full details regarding the Sargent-Rayment Seven. I am a dealer or professional set builder and buy my supplies from the jobbers listed below.

Name.....

Address.....

City and State.....

Name of Jobber.....

Name of Jobber.....

S-M LEADERSHIP means *Better Radio*

The Radiobuilder
SM
Five New S-M Audio Transformers Mark Virtual Revolution in Audio Amplifier Performance
The Radiobuilder
SM
A New High-Powered Public Address Amplifier for Radio Voice or Record Reproduction

Are you receiving THE RADIO-BUILDER regularly? This little house magazine is printed occasionally to provide you with new and advance information on forthcoming S-M developments, and to pass along operating hints and kinks that will help you to get the most out of radio building. Issues, numbers one and two, pictured above are good examples of what THE RADIOBUILDER contains—a practical description of the first light socket public address amplifier available for home construction, and the inside, advance story on the practical phases of the new Clough audio system. with all curves.

THE RADIOBUILDER is newsy, and timely, and, above all, it is the condensed, monthly key to all the detailed constructional data you desire, for in it are listed and previewed all new S M DATA SHEETS each of which can be had for a two cent stamp.

Fill out the coupon below if you'd like to keep abreast of new radio developments.

If you want a veritable mine of Radio information, fill out the coupon and it's yours!

IN four short years Silver-Marshall, Inc. has forged up from obscurity to the position of dominant leadership in the radio parts and kit field—interesting, you say, but just what does that mean *to you?*

S-M leadership means just one thing—better radio for less money. Ask any one of the thousands upon thousands who enjoy radio to the full thru S-M kits and circuits. Ask the multitude of experimenters who have literally used and recommended S-M into first place; who two years ago swept S-M audio transformers into unquestioned leadership thru a veritable avalanche of approving purchases and who have held S-M audios at the top ever since. Ask the thousand odd Authorized S-M Service Stations who have built a profitable business and satisfied customers on S-M stability and worth. Or ask the dealers and jobbers who have seen S-M rapidly crowd competitors from their shelves, to become in four seasons the largest selling, most profitable parts line.

They'll all tell you that S-M leadership means better radio at less cost.

And S-M will lead again in 1928 and 1929 by giving you new developments that enable made-to-order or home-built radio sets to equal in external finish the finest factory productions, parts that place the performance of such sets utterly beyond competition, and, thru knock-down kits, radio receivers that will consistently and positively outperform all ready-made sets at anywhere near their amazingly low prices.

New S-M Offerings Ready August 1st

The 720 Screen Grid Six, a six-tube dual control screen grid receiver kit at $69.75 complete with all-metal assembly, individual stage shielding, and averaging 10 KC selectivity against powerful locals—a set that brings in forty to a hundred stations in one evening. This set can be had for A.C. operation at $74.00 for 171, 210 or 250 power tubes.

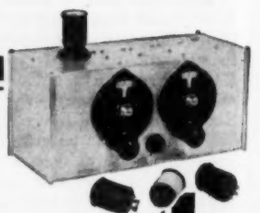
And at $49.75 S-M offers the 740 "Coast to Coast" Screen Grid Four—a kit that is a revelation in four-tube results. Type 700 metal shielding cabinet as illustrated is but $8.50 additional, for either set, finished in attractive duo tone brown. It gives to each a new standard of style and distinction.

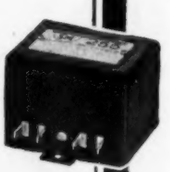
The Sargent-Rayment Screen Grid 7, type 710, is the wonder set of the season, and S-M offers, exclusively, the approved kit at $120.00. It is complete with aluminum shielding cabinet and will bring in 100 stations on any average evening.

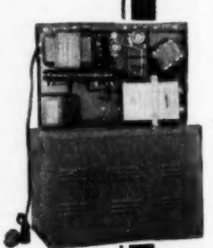
The S-M "Round the World" Short Wave sets are the trimmest, most efficient short wave sets yet, priced from $36.00 to $51.00 complete with shielding cabinet. New S-M condensers are marvels of rigidity and flexibility in Universal single, and triple types. The 685 Public Address Unipac—the first really high-powered amplifier yet offered—is priced at only $160 wired, or $124 for the kit. It will turn out music or voice that can be heard by 1000 to 10,000 people.

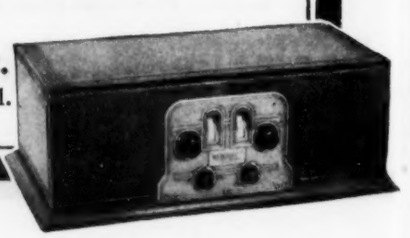
Of course, the most startling audio development of the last two years would logically come from S-M laboratories, as it did two years ago. The new Clough audio transformers have been deservedly the sensation of the June radio trade show. In open comparative tests S-M 255 and 256, $6.00 transformers have excelled the performance of all competitive types tested, regardless of cost. The 225 and 226 transformers at $9.00 each simply leave the most skeptical marveling.

These and many other startling new S-M parts leave small wonder at S-M leadership. They prove that you can get the best radio for the least cost from S-M.









SILVER MARSHALL, Inc.
852 W. Jackson Blvd. Chicago, Ill.

Silver-Marshall, Inc.
852-W. Jackson Blvd., Chicago, Ill.

Enclosed find.....in stamps for which please send me

.....(50c) next 12 issues of THE RADIO-BUILDER, or

.....(1.00) next 25 issues of THE RADIO-BUILDER

Please send me the following S-M DATA SHEETS, at 2c each:

.....No. 1—670B—670ABC RESERVOIR POWER UNITS

.....No. 2—685 PUBLIC ADDRESS UNIPAC

.....No. 3—730, 731, 732 "ROUND THE WORLD" SHORT WAVE SETS

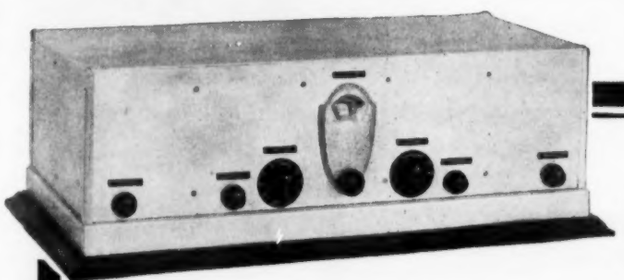
.....No. 4—HOOKUPS FOR 223, 225, 226, 255, and 256 AUDIO TRANSFORMERS.

.....I am a professional setbuilder. I am interested in your Authorized Service Station plan.

S-M 710 Sargent-Rayment

RECEIVER READY FOR DELIVERY AUGUST 1ST

If you order from OFFENBACH ELECTRIC COMPANY NOW!



The Season's Winner

Illustrated above is the new 7 tube SM-710 Receiver, designed by Sargent & Rayment.

A beautiful job in a heavy aluminum case, totally shielding the entire receiver. Most selective set known.

Silver-Marshall's new SM-710 will out-perform any other receiver on the market. It gives clean-cut 10 kilocycle selectivity. Uses 4 shielded grid tubes. 7 tubes in all. Individual vernier controls for each condenser unit. The new Clough system of audio amplification is also used. A totally different method of sound amplification, not surpassed by any other known system. Years ahead of the times.

A RECEIVER so different that it will surprise you. So simple to put together that anybody can do it. Sold either as a complete kit, including the aluminum housing, or as a completely wired ready-to-operate receiver, fully guaranteed to make good all claims advertised. More than 100 outside stations tuned-in at Chicago on a warm summer evening . . . and right through the powerful local interference. Single dial control with verniers. Enormous volume and the finest tone you have ever listened to. Undoubtedly, this receiver will outsell all others in the kit field during 1928-1929.

SPECIAL DISCOUNT TO DEALERS

We specialize in dealer orders. A large wholesale department, stocking more than a hundred lines of standard parts, is at your disposal. Liberal discounts to dealers and professional set builders. Dealers are invited to inquire about the extra special price concession on the SM-710. This special offer holds good only until August 1st. Shipments on the SM-710 will be made starting August 1st. Telegraph your order if you want delivery at once. C.O.D. orders taken when $40.00 sent with order. Tubes, batteries, loud speakers and all standard parts in stock. Order your accessories from us. Our mail order department fills your orders on the same day we receive them. One trial will convince you of our superior service.

USUAL DISCOUNTS AGAIN PREVAIL ON ORDERS MAILED LATER THAN AUGUST FIRST

PRICES

Note—Extra special discount to dealers if you order immediately. Save $6.00 to $9.00 if you act NOW.

The entire SM-710 kit, with aluminum housings, wire and instructions, and including complete audio amplifier, $120.00, list. Completely built up, wired, tested and guaranteed receiver, $150.00 List, less accessories.

Send for free 16 page illustrated booklet.

Get this order blank to us at once. Attach your check or money order for $40.00 to it and pay the C.O.D. balance when shipment reaches you.

ORDER DIRECT FROM

Radio Dealers' Supply Service

Wholesale Division of

OFFENBACH ELECTRIC COMPANY

"The House of a Million Radio Parts"

1452 Market Street San Francisco, California

RADIO DEALERS' SUPPLY SERVICE
Wholesale Division of
OFFENBACH ELECTRIC COMPANY
1452 Market Street,
San Francisco, Calif.

Send me

V .....SM-710 Sargent-Rayment Kit, unwired, List $120.00.

V .....SM-710 Sargent-Rayment Set, completely wired, List $150.00.

for which I attach a deposit of $40.00, the balance to be paid for C.O.D. upon receipt of shipment. It is fully understood that the extra special discount shall be allowed on this order if mailed to you by August 1st.

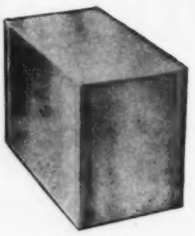
Name .....

Street and Number .....

City ..... State .....

Further *Convincing Evidence*

FIRST THIS—

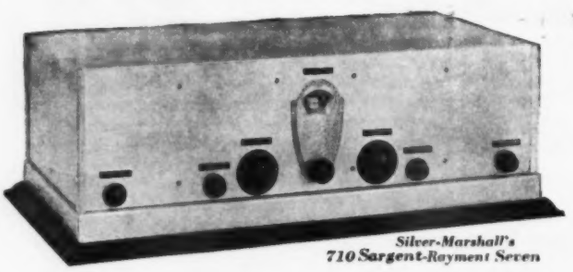


Standard Aluminum Box Shield (5" x 9" x 6" high)

THEN THIS—

Silver-Marshall "Round the World Four"

AND NOW—



Silver-Marshall's 710 Sargent-Rayment Seven

THE superiority of Aluminum for Radio is demonstrated again in Silver-Marshall's new 710 Sargent-Rayment Seven.

Aluminum was the pioneer in shielding with the Standard Alcoa Aluminum Box Shield. Silver-Marshall depend on Alcoa Aluminum as the best metal for Radio uses—an unsurpassed shielding material, with high electrical conductivity and unapproachable lightness.

The Silver-Marshall "Round the World Four" is built entirely within an Aluminum Box Shield (made of Alcoa Aluminum sheet and corner posts), 6" x 6" x 14" in size and has Aluminum base, chassis and front panel.

So successful was this unit *from every standpoint* that, *NOW*, Silver-Marshall introduce their "Sargent-Rayment 7," similarly encased in Aluminum and with Aluminum shielding for each stage as well as Aluminum chassis and sub-panel.

Aluminum is in wide and rapidly increasing use both by amateur set builders and by radio engineers because it is the *one metal* that most successfully meets *all* the varied conditions encountered in radio design.

We will gladly send you on request the booklet, "*Aluminum for Radio.*"

ALUMINUM COMPANY OF AMERICA

ALUMINUM IN EVERY COMMERCIAL FORM

2463 Oliver Building, Pittsburgh, Pa.

Offices in 19 Principal American Cities

ALUMINUM

The mark of Quality in Radio

YAXLEY
APPROVED RADIO PRODUCTS

Air-Cooled Rheostat
$1.35

Built to the Highest Standard

Radio Convenience Outlets
$1.00 up

Add Good Appearance to Set Satisfaction

Insulated Phone Tip Jacks
25c per pr.

Of Its Type the Best

Full Automatic Power Control
$7.50

Junior Rheostat
75c up to 400 ohms

Correct in Design

Midget Battery Switch
50c

Made by Workers of the Greatest Skill

Pilot Light Bracket
50c

Material of the Highest Quality

Cable Connector Plug
$3.00 and up

IMPROVEMENT in radio and the ultimate enjoyment of the radio program has moved impressively along three distinct lines.

On the one hand the development of broadcasting methods has been startling; on the other refinement in the design of receiver circuits has given the radio user a range of operation undreamed of a few years ago. But along with these two great developments the manufacture of parts and accessories has kept pace. And in this direction the Yaxley Mfg. Co. has won distinct recognition.

Yaxley Approved Radio Products, ever since their inception, have been the choice of the designers of many of the most prominent and successful circuits. Today, as never before, the value of a receiver is measured by its dependability. Whether it be of the greatest simplicity or extreme complexity the choice of parts is of vital concern.

A thoughtful selection of Yaxley parts will give you the greatest measure of protection and the most positive assurance of dependability in set performance.

Yaxley products are available at most radio dealers and jobbers. In the meantime, let us send you our latest illustrated descriptive bulletin. Send us your name and address today.

Yaxley Mfg. Co.

Dept. A, 9 South Clinton St., Chicago, Illinois

YAXLEY
APPROVED RADIO PRODUCTS

The New Abox

A. C. CONVERTER

Makes your set Electric

No change in tubes or wiring

All the features that made Abox the outstanding success of last year are retained in this new model. The improvements are the result of untiring research and the experience gained from many thousands of these devices in actual service.

For convenience a receptacle for the "B" unit and a control switch is now standard equipment. A new design and attractive finish adds to its trim appearance.

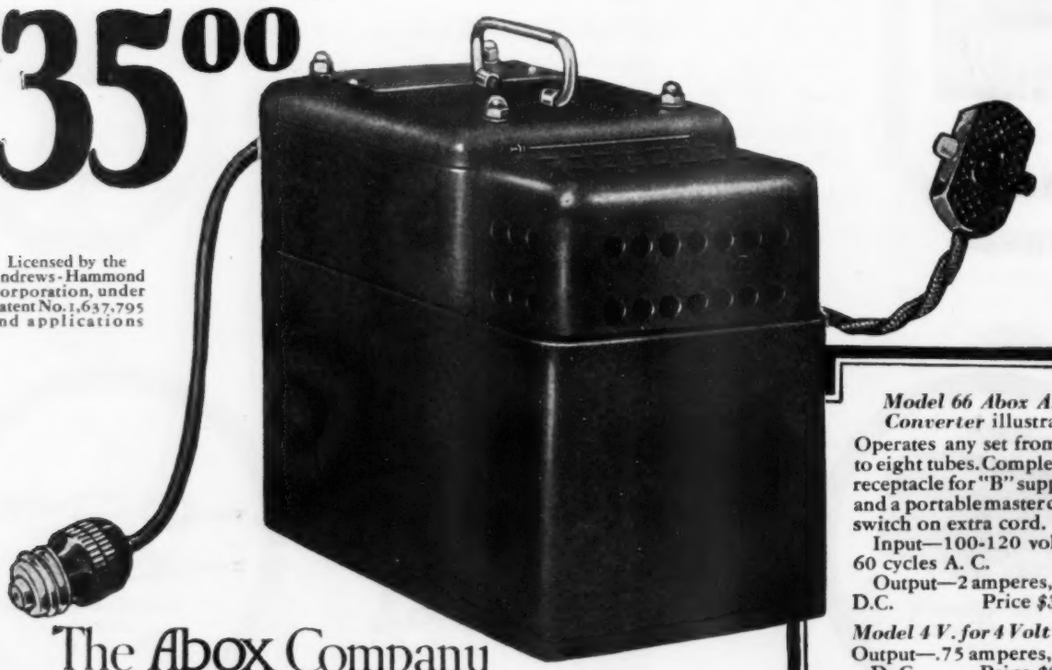
Interior changes in construction give assurance of even longer life and better service.

The reliability and efficiency of the standard D. C. tubes need not be sacrificed to enjoy the convenience of true electric operation. Abox converts 110-volt 50—60-cycle current to hum-free direct current thus giving true A. C. operation. No storage battery is used.

The Abox may also be used to supply current for the 6-volt dynamic speaker.

$35.00

Licensed by the Andrews-Hammond Corporation, under Patent No. 1,637,795 and applications



Model 66 Abox A. C. Converter illustrated
Operates any set from three to eight tubes. Complete with receptacle for "B" supply unit and a portable master control switch on extra cord.
Input—100-120 volts, 50-60 cycles A. C.
Output—2 amperes, 6 volts D.C. Price *$35.00*

Model 4 V. for 4 Volt Tubes
Output—.75 amperes, 4 volts D. C. Price *$27.50*
Prices higher on West Coast

The Abox Company
215 N. Michigan • Chicago, Ill.

BIG PROFITS
To Be Made

BY DEALERS WHO TURN BATTERY SETS INTO POWER AMPLIFIED A.C. ELECTRICS

Through Powerizer's amazing invention—and effective advertising—buyers everywhere will be looking for the dealer who makes every battery set a Power Amplified De Luxe Electric. Wire for details on becoming a Powerizer sales and service station and for Bulletin PR-1 which tells how to make every radio or phonograph a power amplified A.C. All Electric.

RADIO RECEPTOR CO.
106 Seventh Avenue
NEW YORK

Licensed by Radio Corporation of America and Associated Companies

Now—your own dealer will make your battery set an A. C. De luxe Power Amplified Electric

with the famous

POWERIZER
REG

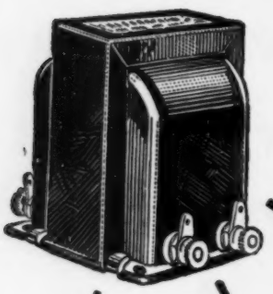
$12.00

IF YOU HAVE A "B" ELIMINATOR—just hook up Powerizer A and install new A. C. Tubes. Easily attached or wired into your set by dealer at nominal charge.
POWERIZER A $12

IF YOU HAVEN'T A "B" ELIMINATOR—just hook up Powerizer Junior and you are all ready for complete A. C. operation. Attach it yourself or have Powerizer dealer wire it into set at small charge.
$35

GET TONE QUALITY OF $500 to $800 RECEIVER

Ask dealer for demonstration of the Powerizer . . . The unit that gives power amplification—the richest tone quality in radio. Bring in those deep tones with amazing realism—greater volume—greater distance. A Powerizer for every purse and purpose.



In Most of The Better Radio Receivers

Watch dogs of tone quality safeguarding the musical reproduction of broadcast programs, Thordarson Audio Transformers do their part in making real musical instruments of hundreds of thousands of receiving sets annually.

Among leading set manufacturers, Thordarson transformers have long been recognized for their fidelity of reproduction. Today their use is so universal that it is difficult to find a dealer who does not sell at least one make of receiver so equipped.

Try this simple experiment. Ask your dealer for a demonstration of his receivers. Pick out the instrument with the most natural reproduction, and then look inside the cabinet. You will find, in the majority of cases, Thordarson amplifying and power supply transformers.

You will realize that it is wise to specify Thordarson amplification when buying your receiver, for the manufacturer who is far-seeing enough to equip his sets with Thordarson transformers, may be depended upon to have the balance of his instrument in keeping with this high standard.

new!

THORDARSON
R-300
AUDIO TRANSFORMER

A superior audio transformer that will satisfy the most critical musical ear. The high impedance windings of the R-300 are wound on a core of D-X Metal, a recent development of the Thordarson laboratory. This new core material has an exceedingly high A.C. permeability, and an inductance that is 50% greater than that of the highest grade silicon steel. In performance, this transformer responds exceptionally well to the lower frequencies and provides the same degree amplification to the diapason of the grand organ as to the note of the flute. Ratio 3:1. Dimensions, 2½" x 2½" x 3" high. Weight, 2 lbs. Price, $8.00.

THORDARSON
RADIO TRANSFORMERS
Supreme in musical performance

THORDARSON ELECTRIC MANUFACTURING CO.
Transformer Specialists Since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Huron and Kingsbury Streets — Chicago, Ill. U.S.A.

8681

Replace your old radio!

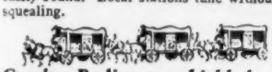
Seven and a half million sets now obsolete

1928 Features

Few radios AT ANY PRICE combine ALL of these features which are essential to today's new radio reception.

AMPLIFICATION
Neutrodyne 10×10×10=1000
Other systems 5×5×5=125

Crosley Radios tune efficiently
Crosley Neutrodyne circuit is sharp, sensitive and selective. Distant stations are easily found. Local stations tune without squealing.



Crosley Radios are shielded
Each element shielded from each other provides maximum selectivity and *is featured* in the most expensively made sets.

Crosley Radios are selective
In crowded districts where many local stations fill the air you find in Crosley radio a means of listening to ONE at a time.

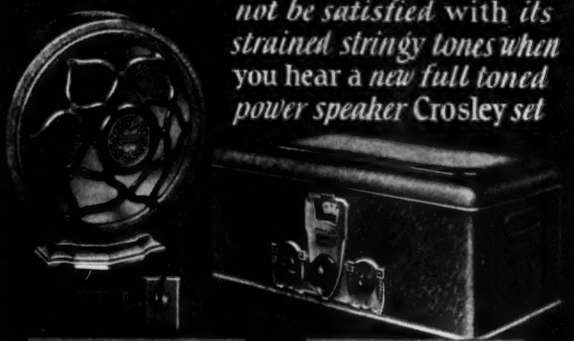
Crosley Radios have volume
Volume may be increased to tremendous proportions without distortion. This provides plenty of volume for power speakers.

Crosley Radios can be softened to a whisper
A positive volume control enables operator to cut any program down to faint and scarcely audible reception.

Crosley Radios fit any kind of furniture
Outside cases are easily removable and chassis are quickly fitted into any type of shape console cabinet.

Crosley Radios have illuminated dials
The modern way enables you to see clearly in the dusk or in shadowy corners.

Your set has served you well *but* you will *not be satisfied* with *its strained stringy tones when* you hear a *new full toned power speaker* Crosley *set*



$25 New Dynamic DYNACONE *Amazing Speaker*

6 tube GEMBOX $65 AC ELECTRIC

FIVE DAYS FREE TRIAL IN YOUR OWN HOME

Crosley originated the idea of a national policy of home demonstration. Home is the place to buy a radio set. Compare a Crosley radio set with any other that you are contemplating buying and you will choose the Crosley. If you have electric current in your home, your set should be a modern, AC electric receiver. A converted battery set is out of date. If you pay more than $65.00 for a radio set, it should have two 171 output tubes, push-pull instead of one, eight tubes instead of seven. To be up-to-date, your new radio set should be designed to take and supply the current for a power or dynamic type of speaker. Crosley sets are so designed. Other sets designed for power speaker use are much more costly. You should demand the tone quality and the performance resulting from high power output coupled with dynamic speaker. Your set should be completely shielded and incorporate the highly sensitive, genuine, neutrodyne circuit. It should have a modern illuminated dial. An examination of Crosley radio sets will show you many other modern exclusive features.

$25.00 NEW DYNAMIC DYNACONE AMAZING SPEAKER!

The Dynacone is a new revolutionary speaker at a price less than many good magnetic speakers. The first minute you hear this new reproducer, it will thrill you to a new conception of what radio broadcast reception should be. Crosley manufacturing speed and straight line methods permit the extremely low price.

WHY PAY MORE THAN CROSLEY PRICES?

We urge you to listen to a Crosley radio set, try it, put it to any test you can think of. No sets that approximate Crosley prices can compare in performance. Why pay a high price for a set that can compare favorably with Crosley–

SIX TUBE GEMBOX AC ELECTRIC, $65.00

Self-Contained AC electric receiver. It utilizes two radio, detector, two audio and a rectifier tube—171 power output tube. Designed for use with the new Crosley Dynamic power speaker. Operates from 110 volts 60 cycle AC house lighting current.
Crosley prices do not include tubes.

1928's greatest radio

8 tube SHOWBOX $80
Genuine Neutrodyne, 3-stages radio amplification, detector, 3 stages audio (last two being 171 push-pull power tubes) and 280 rectifier tube.

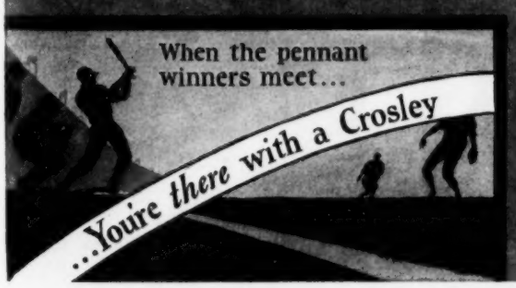
8 tube JEWELBOX $95
Genuine Neutrodyne, 3 stages radio amplification—227 detector tube, 3 stages audio frequency, and 280 rectifier. Shielded coils, modern illuminated dial, highly selective and powerful.

6 tube BANDBOX $55
An improved model of the 1927 receiver that led the world to better radio. Genuine Neutrodyne—every modern fitting and refinement including illuminated dial. The set you can safely buy where AC current is not available—selective, sensitive.

5 tube BANDBOX Jr. $35
Operates entirely from dry cells and is especially designed where no electric current is available either for AC radio or recharging storage batteries.

Improved MUSICONE $15
The outstanding Magnetic type speaker available, still maintaining its leadership, today, as from its inception in 1925. Improved, it is without question the greatest speaker value you can find.

CROSLEY



The Crosley Radio Corporation
Powel Crosley, Jr., Pres.
Cincinnati, Ohio

Montana, Wyoming, Colorado, New Mexico and West, prices slightly higher.

Your name.....

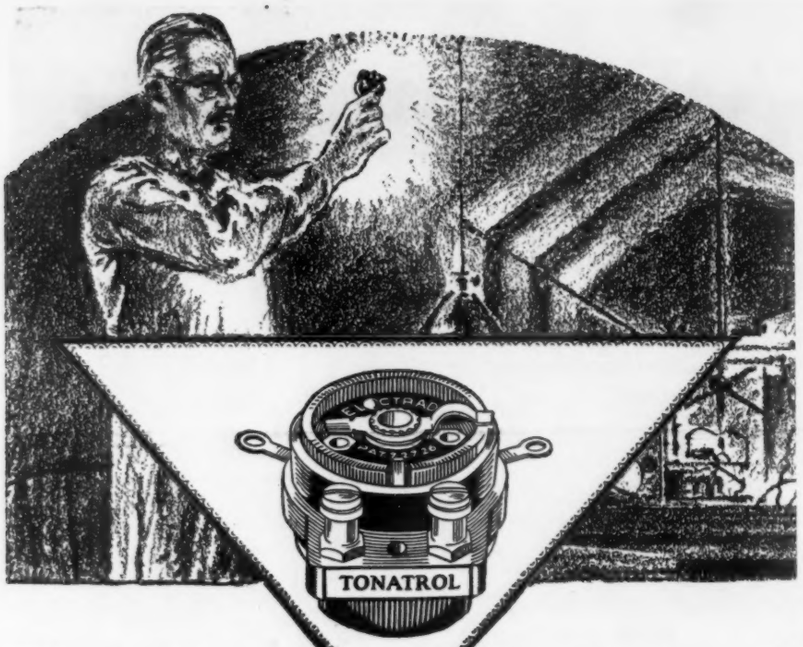
Address.....

5 DAY FREE TRIAL COUPON

Mail this coupon to the factory. Nearest dealer will bring you receiver checked.

Please let me try receiver and proper speaker. I have checked, in my own home without obligation for 5 days

JEWELBOX ☐ SHOWBOX ☐
GEMBOX ☐ BANDBOX ☐ BANDBOX JR. ☐



What About Your Volume?

Controlled Volume Means Improved Reception. By Incorporating Tonatrol in the Set You Build or Own, You Can Control Volume From a Soft, Distant Whisper to the Maximum Volume Which Your Set Will Produce

For clarity of tone and full enjoyment of your radio—smooth, sharp, positive control of volume is an absolute necessity.

In Electrad Tonatrols we offer the highest development in sensitive volume controls. Tonatrols are designed in types to meet all requirements of A.C., eliminator electrified or battery powered circuits.

They are variable resistors of the famous Royalty type and are furnished as regular volume controls or with filament or power switch attached. If the power Tonatrol is not shown here for your receiver, our engineering department will gladly help you select the proper design.

Tonatrol Types P, R and S, $1.50; Type A, $2.00. Battery switch attached 50c extra. Power switch attached $1.00 extra.

Tear out and mail coupon for complete FREE Circulars and Full Information.

TEAR OUT AND MAIL COUPON

ELECTRAD, INC.
Dept. 16-K,
175 Varick Street,
New York.

Please send me descriptive circulars on the following products and put me on your mailing list for similar literature.

.....General Circular
.....Tonatrol Volume Controls
.....Phasatrols
.....Royalty Variable Resistors
....."Electrad Control Manual" (Enclose 10c for mailing.)
....."What B Eliminator Shall I Build?" (Enclose 10c for mailing.)
.....Truvolt Divider Manual (Enclose 10c for mailing.)

I am particularly interested in.....

.....

Name.....

Address.....

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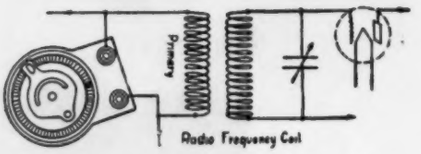

Fig. 1

CIRCUIT DIAGRAM OF TONATROL Type P

TONATROL TYPE P

This type of Tonatrol is designed for receivers of uncertain stability, yet less violent in their tendency to oscillate than the conventional potentiometer stabilized tuned r.f. circuits. Especially recommended for the following receivers and closely similar types: Grebe MU-1; Kolster 6 D; Bremer-Tulley Counterphase 6-37; Fada 8-480 B.S.F. 50/80.

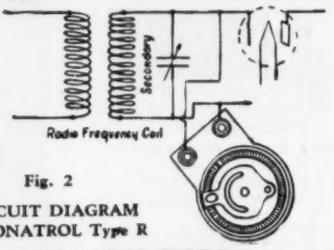

Fig. 2

CIRCUIT DIAGRAM OF TONATROL Type R

TONATROL TYPE R

Tonatrol Type R is designed for connection across the secondary of a radio frequency amplifying transformer as shown in accompanying diagram. Recommended for such receivers as Atwater-Kent; Freshman Masterpiece; home-built tuned r.f. sets; the Paragon models; Bosch models 66 and 76; and Bremer-Tulley Counterphase.

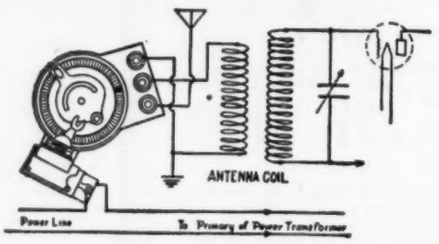

Fig. 3

CIRCUIT DIAGRAM OF TONATROL Type AP

TONATROL TYPE A

Antenna Type for Non-Oscillating Receivers

The above circuit indicates the most simple method of controlling volume. Tonatrol Type A.P. is wired to the antenna and receiver by three simple connections. Adapted only for relatively staple circuits such as Fada 7-475 A.S.F. 45/75; Grebe 7; The Bosch Cruiser; Crosley Bandbox; Stromberg Carlson 501A; Thermodyne T.F. 5; Zenith 11 or 14.

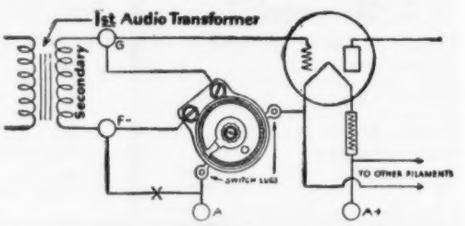

Fig. 4

CIRCUIT DIAGRAM OF TONATROL Type WS

TONATROL TYPE S

Audio Control for Non-Oscillating Receivers

Type S Tonatrol is designed for connection across the secondary transformer of the first audio frequency amplifying transformer. This type is usually used as an auxiliary volume control in addition to an oscillation or regeneration control. Used as suggested it will generally improve tone quality.

ELECTRAD
Inc.

Pacific Coast Office

905 Mission Street **San Francisco, Cal.**

JUL 23 1928

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RADIO

VOLUME X AUGUST, 1928 No. 8

Radiotorial Comment

CHICAGO'S second radio fashion show exhibited a surprising lack of originality and innovation. Each factory seemed to have copied every other factory's t.r.f. in a pretty little cracker-box. This can either be displayed on the parlor table in the nude, or concealed in an ornate piece of period furniture, into which it slips as easily as would a ball-bearing bureau drawer.

Every one of the new radios has *single drum dial tuning* and two or three auxiliary knobs which are more useful than ornamental. There is still no danger of the radio fan losing his ambidexterity. The a.c. filament tube is so much in vogue that it completely eclipsed the more sensitive shield-grid tube, only a few factories having the hardihood to display d.c. models.

The dynamic speaker and its concomitant power tubes were greatly in evidence. At least two dozen manufacturers have already climbed onto the band-wagon, but some of them have forgotten to get license tickets. There'll be an interesting time when the conductor starts to collect the fares, for every band-wagon has its conductor.

Taken as a whole, the exhibits, like the circuits, show greater stability than ever before. Freak circuits and fly-by-night manufacturers are in the limbo of the past. Many former household names were conspicuous by their absence. Some former accessory manufacturers, however, were doubly conspicuous with complete receivers. And now they're off to a most interesting race for sales supremacy.

* * *

HOME rule of radio is the battle-cry which has been raised by the smaller broadcasters whose licenses may be revoked by the Federal Radio Commission. Somewhat side-stepping such legal questions as the Commission's authority to virtually confiscate private property, a number of broadcasters have formed an association to fight for their continued existence on the basis that local broadcasting is fully as important as is regional and national broadcasting. They contend that the voice of the village inspires local pride and ambition. This appeal to sentiment is calculated to affect the general public opinion that radio could be better if the village voices were not in the choir.

* * *

THE congestion between 200 and 550 meters is promoting the use of short wave radio. After the amateurs were forced out of their original space province by the broadcasters, with infinite patience and remarkable ability they pioneered in carving out a new empire in the short wave field. When they had made this new territory habitable, another race of settlers moved in and now the more adventurous amateurs are going to the frontiers of the ten- and five-meter bands.

Today there is more traffic between 20 and 200 meters than there was between 200 and 600 meters seven years ago. Even the BCL can now hear more that he can understand below 200 meters, than he could hear above that wavelength in 1921, when broadcast listening began to be the favorite indoor sport.

A dozen or more broadcast stations in America are already transmitting programs on short waves. They are the new delight of the DX fan. Anybody can hear the locals, but only a favored few can boast of their prowess in getting distant stations on the short waves.

A short wave receiver is to the ear what a telescope is to the eye. It is destined to great popularity, whether as an attachment to an existing set or as a separate instrument. Nor are continental boundaries a limit to reception. London programs have been regularly heard in America during the summer months, and even Holland is being reported in day-time receptions, as are also Melbourne and Java.

Such receivers are now readily available in either factory-built or kit form. Several of the

latter are using shield-grid tubes which are especially helpful in reducing radiation, a precaution which will become more necessary as short wave reception becomes more general.

* * *

WITH an estimated total of seven million radio sets in the United States, three out of every four homes are yet to be equipped. Three-fourths of the number of sets are in the first, second and fourth zones, leaving one-fourth equally divided between the third and fifth zones. These figures are not accurate, but are believed to be as good an approximation as it is now possible to secure.

They show that a great market for radio is yet to be developed. Considering the ratio of number of installed receivers to the number of homes, the first and fifth zones have been most highly developed, each have a twenty-five per cent higher ratio than the second and fourth zones and one hundred per cent higher than the third zone.

* * *

IN CONFORMITY with the zone equalization instructions of the last Congress, the Federal Radio Commission has been holding hearings as to why about one-fifth of the stations now broadcasting should not cease to do so after the first of August. A second list will soon question the public service being given by nearly two hundred more stations, so that by the end of the year half of the stations now on the air will have been called to give an account of their stewardship. As some of these stations may fail to qualify, there should be a material reduction in heterodyne interferences. Thereafter the Commission will probably consider the amount of power which may be used by each station. This allocation should be on the basis, not of nominal wattage, but of area adequately served.

The effective service areas of the principal stations are now being surveyed by the Department of Commerce with specially equipped automobiles in various zones. These cars are equipped with sensitive instruments for measuring the field intensity at various distances from the stations. Thus if it is found that a certain station is not "getting out" its power can be increased or steps taken to give more effective radiation of the power which is already being used. Preliminary tests have shown many cases of inadequate service due to inefficient use of power.

The Department might well undertake to meet another requirement, that of checking the frequencies or wavelengths used by broadcasters as well as commercial and amateur stations. This could be done by the installation of a number of standard frequency monitoring stations. These listening posts might be located at strategic points throughout the country, so that eventually it could be possible to measure the frequency of any station in the world which can be heard in the United States. As these measurements can be made with an accuracy of one part in a million, and could be conducted continuously, each station might be informed as to its maintenance of the frequency which has been assigned to it.

The combined effect of eliminating poor stations, increasing or decreasing the power used, and maintaining constant frequency should provide greatly improved broadcasting conditions. These improvements should be brought about, not on the basis of favoritism, but upon the maintenance of standards as observed and reported by trained field men.

The one obstacle in sight is the possibility, though not probability, of legal decisions which may restrain the Commission in the exercise of the powers which have been conferred upon it by Congress. If these decisions are predicated upon service to the public rather than upon private profit to the individual, it is likely that there will be fewer stations and less interference next year than now.

* * *

MARK TWAIN would have made a wonderful radio critic. "Everybody," he said, "is always complaining about the weather, but nobody does anything about it." Change *weather* to *radio* and see how pat it is today.

* * *

THE pentode is the latest addition to the vacuum tube family. It is a five-element tube having three grids. As an audio frequency amplifier it is claimed to have a mu of 80, which compares favorably with the claims for the screen-grid tube as a radio frequency amplifier. This super-power tube readily takes the place of two tubes, as this brings within range of possibility a three-tube portable set whose performance will equal that of the average six-tuber.

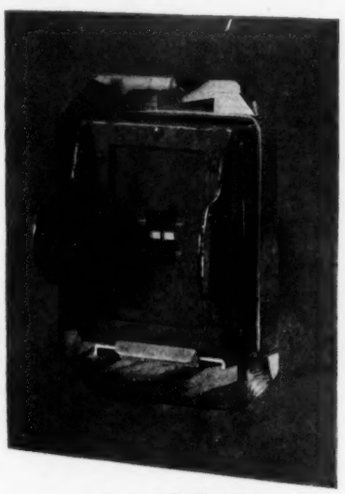
Radio Aids for Aerial Navigation

A Description of a Receiving and Transmitting System Which Obviates Headphones

By S. R. WINTERS

ELIMINATION of the pilots' chief objections to the radio equipment of aircraft, the head telephone and the trailing wire antenna has been made possible by two novel arrangements devised by the radio laboratory of the Bureau of Standards. The headset is replaced by a visual indicator which shows when a plane is on or off the course marked by a directive aerial beacon. A short vertical rod displaces the dangling wire, which frequently lashes itself to pieces and is a constant source of trouble to the pilot.

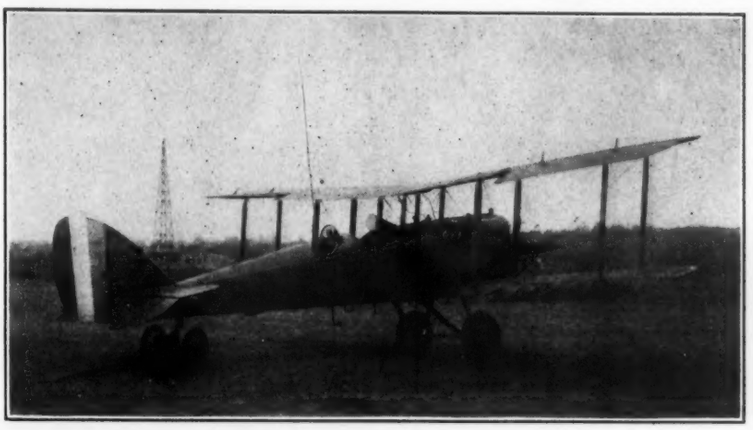
The visual indicator is mounted on the instrument board in front of the pilot and consists of two vibrating reeds whose terminals are plugged into the phone-jack of a sensitive receiver mounted in the tail of the plane. These reeds are actuated by beacon signals transmitted from two crossed loop antennas at the beacon station, both transmitting a 290-k.c. radiation, but one modulated with 85 cycles and the other with 65 cycles. The left reed is tuned to 85 cycles and the right reed to 65 cycles and each has a white tip which shows as a white line in the indicator.



Beacon Indicator

If the two white lines are equal in length, the pilot is on the correct course. If the one on the right is the longer, the plane is off to the right of the appointed course when the 65 cycle modulation is in excess. If the plane swerves to the left, the white line on the left side of the indicator becomes longer, as the intensity of the 85 cycle modulation increases.

The indicator can also be used for sending messages to the pilot by interrupting the transmitted radiation at a slow rate in accordance with a prearranged code. Additional vibrating reeds, in resonance with other frequencies, can be used to transmit special information. When one beacon station uses modulating frequencies of 65 and 85, the next station can use 75 and 95 cycles, etc., several pairs of vibrating reeds being installed for their reception.

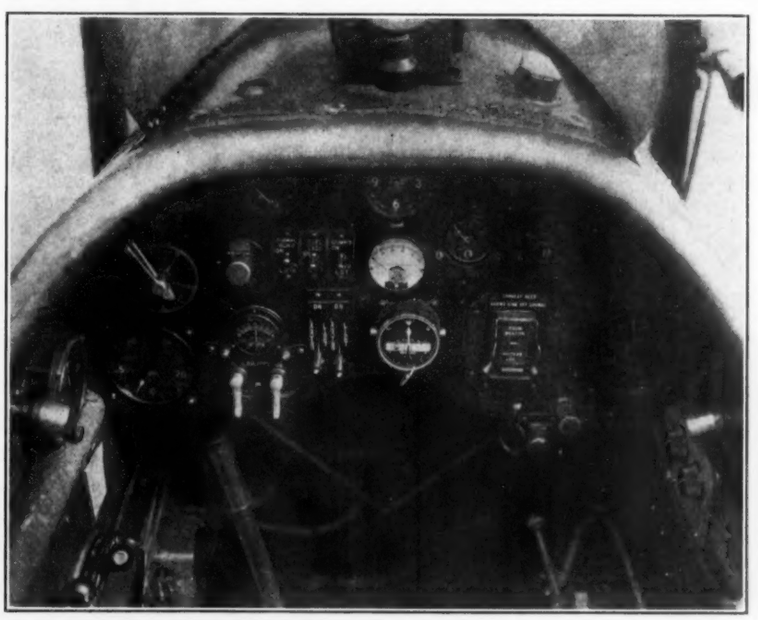


Plane Equipped with Vertical Antenna

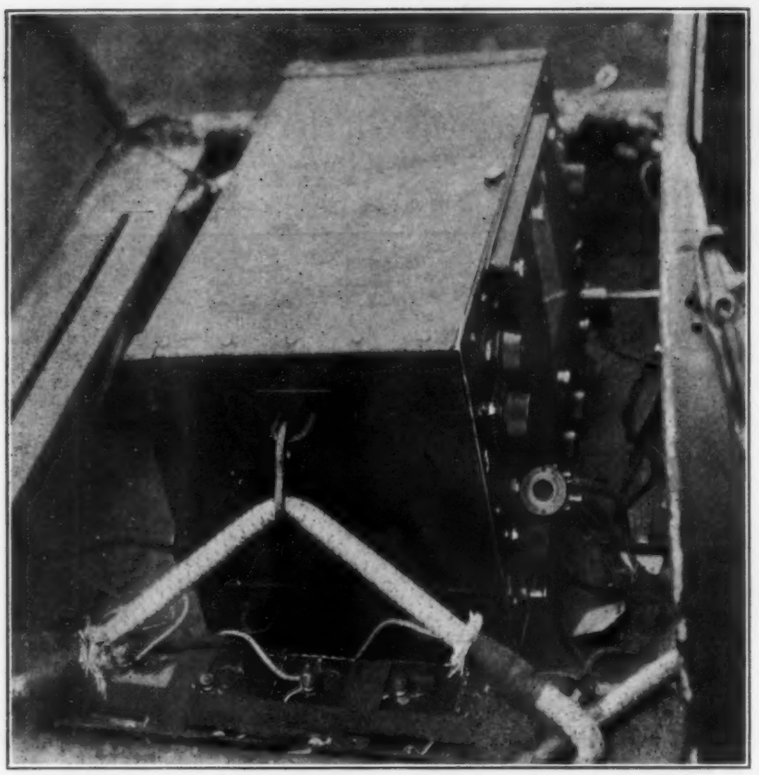
The trailing wire antenna is replaced by a 10-ft. metal rod, mounted erect in the cockpit. This is somewhat at the expense of distance range, but makes for more exact location of a beacon station. Its use requires an especially sensitive receiver.

Such a receiver, weighing only 15 lbs., appears in an accompanying picture. It is designed to be tuned from 285 to 350 kilocycles and may also be used for the reception of radio telephone and telegraph messages, being arranged for remote control of tuning and volume. It is doubly shielded and shielding of the engine ignition system is also employed. Its circuit diagram is shown in Fig. 1.

The directive radio beacon station, from which the signals originate, is usually located near the landing field of an airport. It employs two loop antennas crossed at an angle of 90 degrees with each other. Each of these emits a set of waves which is maximum in its plane and a minimum at right angles thereto. A master oscillator, producing 290-kilocycle current, feeds two power amplifiers. These are modulated by two different low frequencies. Their outputs



Instrument Board Equipped with Beacon Indicator



Receiver Used with 10-Foot Antenna

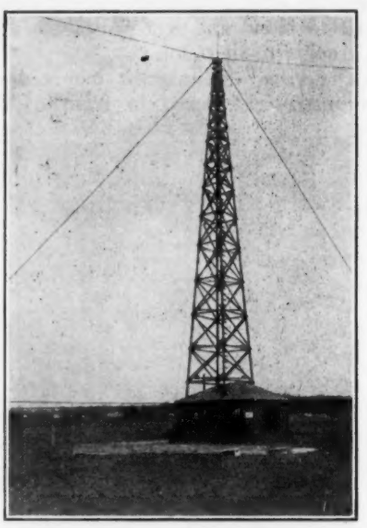
go separately to the two loop antennas.

"The two loop antennas," relates the Bureau of Standards, "terminate in tuning condensers and coils. They are both tuned to 290 kilocycles, and so adjusted that there is no coupling between them. The coils are coupled to the plate circuits of the two 1000-watt amplifiers. The plate circuits are untuned, which reduces intercoupling between the two tuned loop antennas through the plate circuits of the power amplifiers. A radio-frequency voltage is supplied to the grids of the two amplifiers from the 50-watt oscillator operating at 290 kilocycles with direct voltage (not shown in diagram) applied to the plates.

"The plates of the amplifier tubes are supplied with high-voltage alternating current through transformers, one being connected to a source of 85-cycle voltage and the other to a source of 65-cycle voltage. These are the two modulation frequencies, to which the reeds of the visual indicator are tuned. Each power amplifier passes radio-frequency current every alternate half cycle, the frequency being 85 or 65 cycles. This occurs each time the plate is positive. The completely modulated output from one amplifier supplies power to one of the antennas only, and the other amplifier supplies only the other antenna.

"The use of a common master oscillator prevents any shift in the indicated course due to tuning of the receiving set, which might occur if two master oscillators were used in case they differed slightly in frequency. The description is illustrative only. In practice means must be provided to prevent the production of harmonics.

"A number of other methods for modulating the carrier frequency at the low frequencies required are possible and have been used. The method just described involves the supplying of plate power directly to the amplifier tubes at the low frequencies desired. This method was not found entirely prac-



Radio Beacon Tower at College Park, Md.

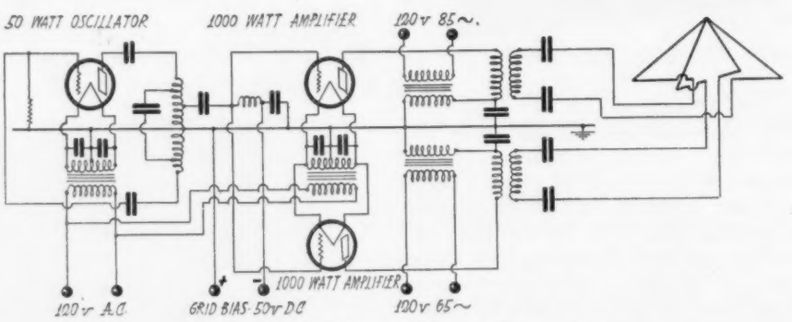


Fig. 2. Circuit Diagram of Beacon Transmitter

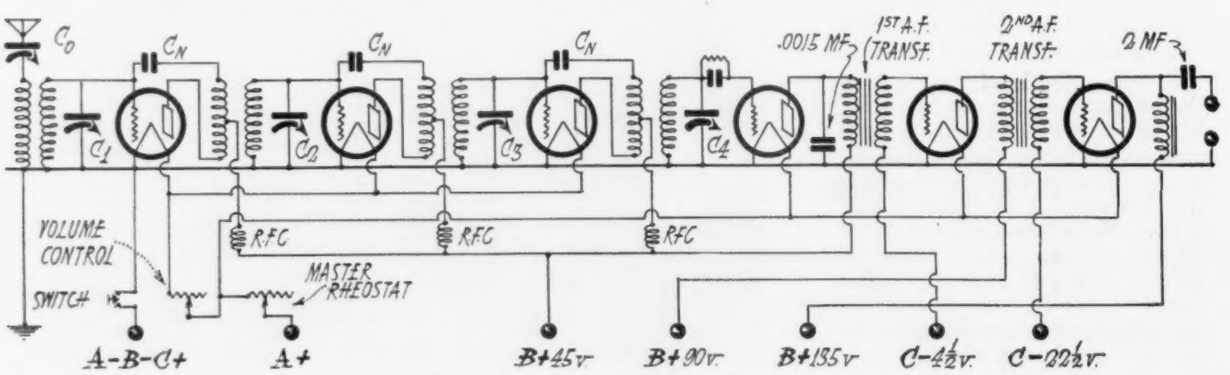
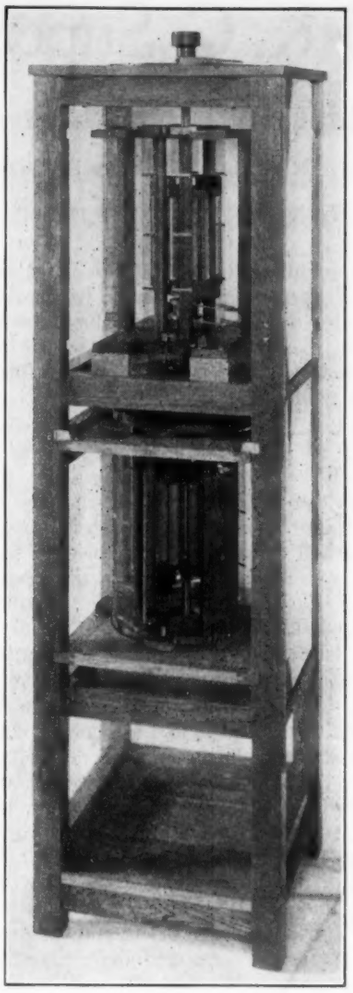


Fig. 1. Circuit Diagram of Beacon Receiver

ticable because the constancy of the low frequencies depends upon the steadiness of the frequency of the power source available, which in most cases varies somewhat. Even with a steady source available, alternators with synchronous motors of special design to drive them would be necessary.

"Vacuum-tube oscillators controlled by tuning forks which supply sufficient voltage to enable grid or plate modulation of intermediate amplifiers have been developed, and solve the difficulty of keeping the low frequencies steady. In the grid modulation method the modulating frequency is impressed upon the grid of one of the amplifier tubes. With the plate modulation method the low-frequency voltage is applied to the grids of modulating tubes, the plates of which are connected to the output of one of the amplifiers in a circuit arrangement analagous to that of the ordinary method of plate modulation employed in broadcasting stations. Both methods give satisfactory performance, although the plate modulation scheme has some advantage in that less distortion of the wave form is introduced.

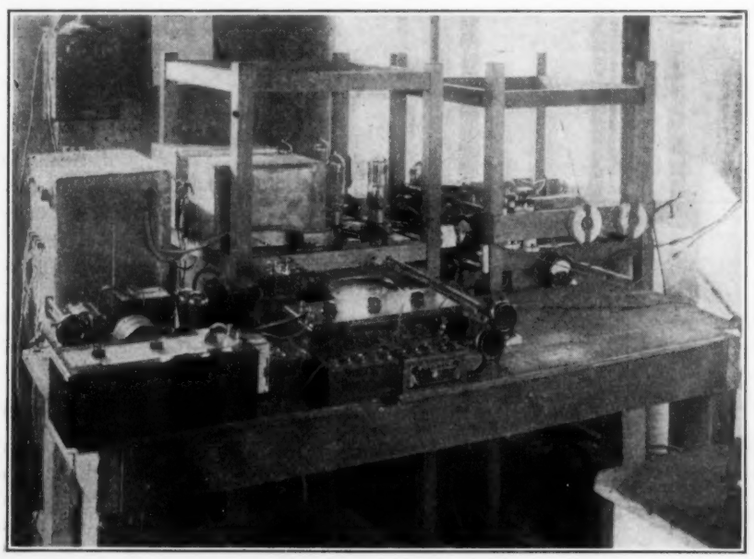
"When the beacon is to be used for air routes in several directions, a goniometer (not shown in the beacon transmitting station diagram) must be introduced. This is a coupling arrangement connected between the antennas and the amplifiers, rotation of which is equivalent to rotating the antennas. The goniometer has two pairs of coils, each pair consisting of an 8-turn rotor and a 32-turn stator. The stator coils are fixed at right angles to each other, and so are the rotors. Rotation of the rotor coils with respect to the stators orients the course marked out by the beacon in any desired direction. At airports where several courses intersect the beacon course can be set successively on the several courses for fixed time intervals.



Direction Shifting Goniometer

"The directive beacons at College Park, Md., and Bellefonte, Pa., operate on one kilowatt. Such beacons, located about 200 miles apart, would give satisfactory beacon service when the course usually flown is practically a straight line between them. Where the course varies in direction, lower power beacons at the turning points could be used. Where the course is straight for a considerable distance, such as 200 miles, it is planned to utilize a supplementary feature called 'marker beacons.'

"The directive beacons successfully guide a pilot along the course but give him no information of the distance traversed along it. This lack is supplied through the installation of non-directive beacons, placed along the airway at short intervals (perhaps 25 miles). These marker beacons are of very low power (a few watts), and emit a characteristic signal which the airplane pilot will receive for one or two minutes. They tell the pilot when he is passing over a specified place, so that he can locate himself and always know his position. In fact, through keeping track of these marker beacons, the pilot will be able to gauge wind conditions and note any change in direction or velocity as he proceeds during flight. The marker beacons operate a 60-cycle reed vibrator mounted alongside the directive beacon indicator on the airplane's instrument board. Each marker beacon will send the characteristic signal assigned for its location, which will coincide where possible with the characteristic flash signal of the light beacon at the same location. Thus the marker beacon signals will come to the pilot in a logical and automatic manner."



Beacon Transmitter

AN INTERFERENCE BLOOD-HOUND

By MAX P. GILLILAND

THE more sensitive receivers whose tubes are connected directly to the power line by a small transformer are prone to pick up noise carried over the transmission lines. To run down this and other types of interference some sort of a trouble shooting set is necessary.

A loop set seems best fitted for this type of work. It has sharp tuning, is directional, and usually is sensitive and easily transported. In the outfit here described a super-heterodyne was used because it would pick up racket better than any other circuit.

The Southern California Edison Company, whose men have made a name for themselves in trouble shooting interference, has found that the human ear is deceptive as to the strength of a signal. It hears logarithmically. The answer is a visible indicator.

One dealer installed his outfit in a Ford coupe. On the right hand side, directly back of the door hinges, were placed special brackets. These supported and permitted the revolving of a 1-in. dowel some 6 ft. long. On the end of the pole and nicely clear of the car top, was mounted the loop. By means of a plug fastened to one spoke of the loop

(Continued on Page 48)

Adapting the 115 K. C. Super to Short Waves

Simple Directions for Adding an Antenna Switch and Substituting Three Home-made Plug-in Coils

By MAYNARD J. COLUMBE

AFTER listening at Plattsburg, N. Y., to 5 S W, Chelmsford, England; F 8 G A, Clichy, France, and other foreign stations every afternoon on short waves, as well as the various U. S. stations, I have become convinced that the few changes necessary to adapt the 115-k.c. superheterodyne to short wave reception are well worth while. This is readily accomplished by the use of plug-in coils and a very few changes in the circuit, at negligible cost.

As only one r.f. amplifier stage is used, the first change is to mount a two-point antenna switch such as a single pole double throw knife switch on the

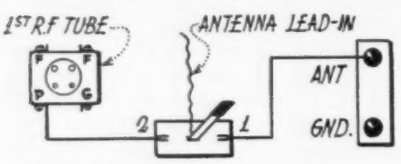


Fig. 1. Antenna Switch for Short-Wave Reception.

baseboard as shown in Fig. 1. This switch is in position (1) when the regular 200-600 meter coils are used, and in position (2) when the short wave coils are used.

The short wave coils can be wound either on the regular blank forms or on the bases of burned out U X tubes whose prongs fit the regular coil sockets. Six of these coils are necessary, r.f., detector, and oscillator for the 17-35 meter and 30-70 meter wavelengths. The required number of turns is given in the following table, No. 18 wire being used for the secondary and No. 26 for the primary and tickler:

Fig. 2 shows how the detector coil may be made from a tube base from which the side pin has been pulled. The glass can be removed from the base by putting it in cold water which is brought to a boil for five minutes so as to melt the wax and then heating the prongs with a gas flame until the solder is melted. Bore a hole through the side of the base ⅜ in. from the bottom and directly beneath the pin's former location and bore a second hole diametrically opposite the first and the same distance from the bottom. These are for the tickler contacts. Then bore two opposite holes near the top of the base to support the trimmer condenser brackets. Two holes should also be bored through the side of the base for the secondary winding, one being ½ in. from the bottom and above one large prong and the other ¼ in. from the top and above the other large prong.

Fasten a long soldering lug inside of each of the tickler contact holes, holding it in position by means of a small machine screw passed through from the inside of the tube base and held in position by a nut threaded over it from the outside. These contacts may be omitted if regeneration is not used.

Wavelength Range in Meters	R. F. COIL		DETECTOR COIL			OSCILLATOR COIL		
	Primary Turns	Secondary Turns	Primary Turns	Secondary Turns	Tickler Turns	Grid Turns	Plate Turns	Pick-up Coil Turns
17-35	4	5¾	18	5¾	6	3¾	3¾	3
30-70	6	8¾	27	8¾	9	4¾	4¾	5

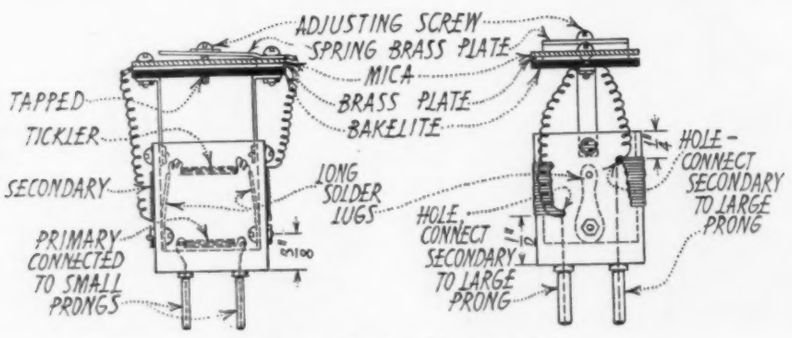


Fig. 2. Construction of Detector Coil

The primary is a self-supporting coil. ¾ in. in diameter, tied with thread and placed in the bottom of the base, soldering its two ends to the small prongs. The tickler is made in the same way as the primary and connected to the soldering lugs.

The secondary is wound around the outside of the base, its ends being passed through the holes bored for this purpose. One end is soldered to one of the large prongs and the other end to the other prong. Before soldering the secondary

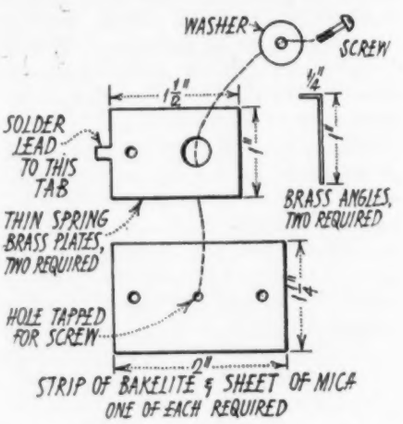


Fig. 3. Construction of Trimmer Condenser

wires to the prongs, solder a 4-in. length of small wire to each prong, these leads being used to connect the trimmer condenser to the secondary.

The trimmer condenser may be made as shown in Fig. 3, or an XL adjustable condenser can be used. It may be mounted on the coil by means of two brackets cut from sheet copper or brass. The two leads across the secondary are connected to it. This trimmer is placed on the coil so as to avoid disturbing those on the gang condensers which have been balanced for the 200-600 meter coils.

The oscillator coil is like the detector coil except that it has two windings on the outside of the base instead of one. The trimmer condenser can be left off. The r.f. coil has a trimmer but no tickler, so the two contacts near the base are not necessary.

This receiver is also excellent for c.w. reception when the intermediate is made to oscillate. Amateurs from nearly all over the world have been received at 8 U Y with R6 to R9 audibility on the loud speaker. It is very flexible and the tuning is not critical, even on 20 meters.

Radio Picture Transmission and Reception

Photoelectric Equipment and Methods for Visual Communication

By JOHN P. ARNOLD, *Departmental Editor*

WHEN a writer holds forth in a radio magazine under the seven-syllable, compound title of *photoelectricity,* its readers may inquire in what way this subject relates to radio. Anticipating this demand, explanations are tendered without further ado.

Photoelectricity, in a general sense, refers to any electrical effect produced by the action of light. The photoelectric cell is the practical device which transforms light energy into an electric current.

These cells, in common with the radio tube, amplify weak currents, operate as detectors, and may be used in oscillating circuits. The photoelectric effect has been observed in some radio tubes and in rectifying crystals. Talking moving pictures, sound recording, the photophone, and the control of power circuits, etc., by light are indirectly related to radio. Phototelegraphy and television, for which light sensitive cells are employed, are unquestionably a part of radio communication.

With so much in common, there is no impropriety in bringing the interesting topic of photoelectricity to the attention of the radio man.

Most of the recognized authorities in the field prefer the terms *phototelegraphy* and *television* to designate two phases of the art of *visual communication,* the latter term being of my own coinage and enjoying no extensive reputation. Phototelegraphy refers to the electrical transmission and the reception of "still" pictures, photographs, drawings, etc. Television, literally seeing at a distance, implies the additional factor of action or movement.

These terms have become confused in the public mind and unfortunately, but perhaps intentionally, there are those who appear to be trying to keep this misconception alive. Phototelegraphic apparatus has reached the stage where an outfit which will receive pictures satisfactorily may be purchased at a reasonable price. Television is nowhere near this stage of development. Manufacturers of phototelegraphic apparatus would do well to point out specifically that their products are not a part of present-day experimental television and then concentrate on making it clear that the reception of still pictures has definite news and entertainment values which will be of interest to the radio public.

What Have You?

John P. Arnold, editor of this department will be glad to answer questions (providing he knows the answers) of any experimenter interested in photoelectric cells and their applications. Questions of general interest will be published here, but he will answer by letter any request for specific information if the usual amenities of such correspondence are observed, namely, the inclosure of a self-addressed, stamped envelope. He may be reached at 1114 Spruce Street, Philadelphia, Pa.

Within the next few months apparatus for the reception of "still" pictures (that is, phototelegraphy, not television) by radio will be readily obtainable. The purchaser of such equipment, as well as the radio experimenter, will require some background of information in order to judge the merit of the apparatus placed upon the market. It is hoped that the data presented in this and succeeding articles will be helpful in making such decisions.

It is the aim of manufacturers of this apparatus to conform as closely as possible to the present methods of broadcasting in order that existing equipment will not have to be discarded. In regard to reception, any good broadcasting receiver which will amplify the picture signals without introducing serious distortion will be satisfactory. With such a receiver, the equipment for printing the picture is merely substituted for the loudspeaker.

Before taking up the subject of the various receiving systems, since detailed information is not available at this time, it should be interesting to know how experimenters in the past have approached the various problems of phototelegraphy as well as what is now being done in the field of commercial picture transmission.

In this article we will consider the first of two general methods of recording the picture at the receiving station. The pictures may be printed either by (1) visible or (2) invisible processes. Visible recording, with which we are here concerned, is the case where the image is built up before the receiving operator's eyes; while, with invisible methods, such as recording on photographic paper, it must be "fixed" or developed before the latent image can be seen.

The advantage of the visible processes are obvious. The receiving operator has every opportunity to adjust the apparatus under his control to obtain the best possible picture. He can observe whether atmospheric conditions are affecting the communication channel, whether synchronism is being maintained throughout the transmission and whether the receiver is properly adjusted for the subjects transmitted. He is also able to control the "tone range" of the picture, that is, the graduation of shades or tints of the original picture. Thus, errors may be forestalled by the skillful operator who, if the picture were being recorded by a photographic process, could not notice any defects until after the picture had been developed and printed. Morever, inconveniences and delays are avoided.

In order to study the various methods of visible printing, it might be well to have in mind a complete transmitting and receiving system. Fig. 1 shows the

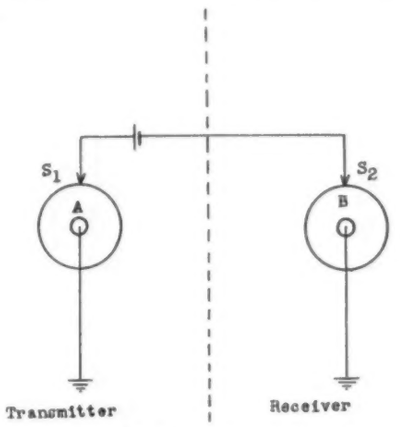


Fig. 1. The Bakewell Visible Recorder

apparatus of Bakewell, whose improvements to earlier systems persist to the present day. The metal drums or cylinders, *A* and *B* at the transmitting and receiving stations respectively are of exactly the same size. These cylinders are moved, as they rotate, along the direction of their axis, by means of a threaded shaft. We are not concerned with the means of obtaining the synchronism between the drums, but the effect is that the stylus S_1 at the transmitter and stylus S_2 at the receiver are always over the same point of each drum as they follow a spiral path around the circumferences of the drums.

The picture to be transmitted is placed on *A* and paper to record the image on *B*. Disregarding the transmitting method signals are sent over the communicating wire as either interruptions or variations in intensity of an electrical current. These interruptions or variations may represent the color, shade or "tone" of

the small area over which the transmitting stylus S_1 rests at any particular moment. The receiving stylus, being at the same relative point as S_1, makes a mark that corresponds with that of the original picture.

Inking and perforating devices provided the earliest means of making visible records. In the simplest form such instruments consist of an electromagnet, the armature of which carries a stylus, which presses upon a paper tape moved by clockwork. For instance, the stylus or marker may be a wheel which is partly immersed in a pool of ink when no current is passing through the windings of the electromagnet, but when a picture signal energizes it, the armature brings the stylus in contact with the paper tape and is held there for the duration of the signal. Instruments of this type have been highly specialized for the reception of telegraphic signals at high speeds.

They may also be used for making *intermediate* records for picture work.

A modern system of this type is the Bartlane process. The picture is analyzed or scanned in the usual way and the variations of light and shade recorded on a perforated tape. These are transmitted by regular communication channels and received again on a tape. This tape is placed in a suitable optical system and an image of the original picture is recorded on a photographic film.

A further development of the mechanical inker is shown in Fig. 2. The current passes through the coil of the electromagnet *M* and as the disc *A* with the mechanical arm *APS* is attracted to one or the other of the poles of the

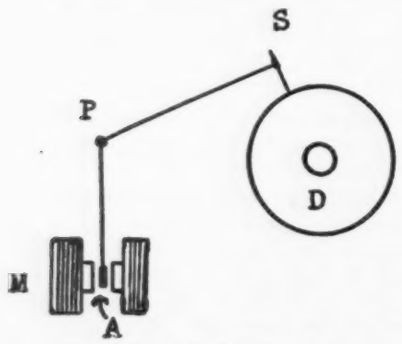


Fig. 2. Mechanical Inker

electromagnet, the stylus *S* is raised or lowered, making and breaking the contact with the paper placed on the revolving receiving cylinder. The stylus may be a pen or a capillary inker, such as the siphon galvanometer. Properly constructed, with a current of two milliamperes, 150 signal impulses per second can be recorded. Higher speeds are obtainable by using wax inks which are heated and in a fluid condition. Such instruments are probably too delicate and too expensive for amateur phototelegraphy and, therefore, we pass on to processes which make use of chemically treated papers.

In 1842 Bain invented the chemical "telautograph," and for the first time recorded pictures by passing an electric current through chemically treated paper. The paper was saturated with a solution of potassium iodide in starch and laid in a moist condition, on a metal plate. The picture signals passed through the paper from metallic contact springs to the plate. The current liberated the iodine and, forming a complex reaction product, turned the starch in the paper blue.

Much experimental work still remains to be done toward the development of chemical papers which cause discoloration by electrolysis. Friese-Greene (British patent No. 27,243, 1897) has suggested various formulas, but these require heavier currents than those available for phototelegraphy. The following data may be of interest to the experimenter who wishes to develop his own paper:

A red discoloration is obtained by using a needle made of copper selenide and moist paper. Phenolphthalein and potassium chloride and also paper treated with a 10 per cent solution of sodium chloride with copper electrodes (that is, the stylus and drum which makes contact with the paper) also make a red mark when a current passes through the paper.

Ten per cent solutions of sodium sulphide with copper, iron, nickel or antimony electrodes mark the paper black.

Wein states "that the trouble with some of these materials is that the metal needle or stylus is either worn off with time or that an oxide or sulphide is formed on the spot where contact is made with the paper, thus increasing the contact resistance and necessitating an increase in voltage, which may be detrimental for the best working conditions. Another disadvantage, which is met in practice, is the fact that some of the compounds formed as a result of chemical reaction by electrolysis are unstable, the product of the electrolysis being affected either by atmospheric changes or by light." Thus for permanency it is best to photograph the chemical image.

A German patent (No. 53,858, 1889) suggests paper impregnated with iron-gall ink and dampened with ammonium sulphate. The action of the current is to bleach the paper.

Other materials have been used for this electrolytic method of printing. Friedel mentions that impregnating the paper with a solution of potassium ferrocyanide and sodium nitrate will make a blue mark with the passage of a current of 20 to 30 milliamperes, and also potassium iodide made into a paste with starch, with the addition of calcium chloride, will record about 300 signals per second with a passage of 40 milliamperes. These markings will fade in time with the evaporation of the liberated iodine.

Martin suggests the choice of a paper that is sufficiently absorbent to remain moist during the time of receiving, but also having a surface smooth enough so that any excess of solution will not spread and blur the picture. He gives this formula: ¼ ounce potassium ferrocyanide, ½ ounce ammonic nitrate and 4 ounces distilled water. One milliampere is required to decompose the solution. As the resistance of the paper may be from 1000 to 3000 ohms, it should always be kept in a moist condition during reception in order that this resistance does not increase and cause faint markings on the paper.

In choosing the proper materials for treating the paper, it should be remembered that the decomposed materials must be colored, while those which are not decomposed must be colorless.

Baker has observed that distortion of signals over long wire lines is largely due to capacity effects and in the electrolytic printing this is evidenced by an elongation of the markings and a blurring of the picture. Theoretically, the length of the mark on the paper measured along the circumference of the cylinder would be determined by $l=tu$ where l is the length of the mark, t is the duration of the current and u the velocity of the surface of the drum. Since the capacity of the telegraph line affects this relation the passage of a current in the reverse direction will clear up the residual current in the line. Moreover, by this reverse current, the degree of contact in the received picture may be controlled and also, by using stronger currents in this direction, a negative, instead of a positive, print of the original can be made.

In the Ranger system of sending pictures by radio, visible images are produced at the receiving station by directing a warm blast of oxygen on a paper treated with a nickel salt, thus forming a nickel oxide on the surface of the paper. This method is described more fully as follows:

"Back and forth, in front of the slowly advancing paper, travels what is called a hot-air gun. This gun is shooting air heated electrically at the paper, and when the hot air hits the paper, it makes a sepia mark. To control the action of the hot air and build up the picture, the hot air is either allowed to hit the paper directly, or is blown aside by a cold air stream on the side of the gun. This cold air stream is controlled by a very small electrically operated valve. If the valve is shut, the cold air is shut off, and the hot air has a free chance to make a good mark on the paper. This is the condition when there is a signal coming in on the radio, which actuates the valve to close off the cold air supply. The radio signal comes in when the photoelectric cell at the transmitting station is being traversed by a light passed through the film in the glass

cylinder. As this occurs for every part of the picture where there is a clear space, a black mark will be registered at the receiver. As the transmitting film is a negative, it means that the clear spaces of the film are the ones to register black on the recorder which is just as it should be to make a negative into a positive; so, bit by bit, as the light at the transmitter and the hot air gun at the receiver travel back and forth, in strict

Portrait Reproduction by Photoradio

time with each other, the finished picture is built up."

Fig. 3 shows one of the types of receivers used for this system and the examples of visible printing illustrating this article were made by this process.

Various other visible printing methods have been tried. Bain, in his improved system of 1883, and Amstutz, about that time, had the picture currents control the impressions made by a V-shaped engraving tool in wax or lead. The incisions made by the cutting tool represented the light and shade of the transmitted picture.

Charbonelle, in addition to using the engraving tool for recording pictures, also placed a sheet of carbon paper over a piece of white paper wrapped around

Replica of Check Transmitted by Ranger System

Fashion Picture Transmitted by Photoradio

the receiving drum. The printing was done by the contact of a stylus, attached to the center of the diaphragm of a telephone receiver, through which the signal current was passed, the vibrations of the diaphragm corresponding to the interruptions of the current, thus marking the paper underneath the carbon sheet.

Knudsen, who first demonstrated the possibility of receiving pictures by radio, caused a stylus to scratch an image of the picture on a glass plate covered with lampblack. A photographic print was then made from this plate.

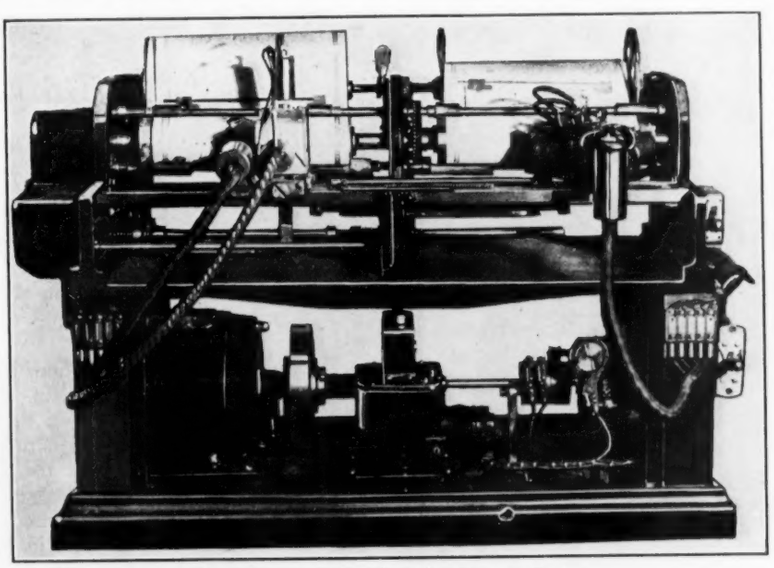


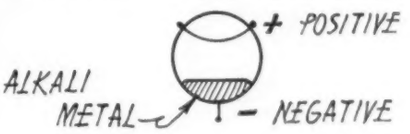
Fig. 3. R. C. A. Receiver for Ranger System

Barnum Was Right

We have received this somewhat equivocal communication from a good friend: "Here is further evidence (!!!) that *television is here at last.*" (Neither the italics nor the exclamations are ours.) The evidence seemed to be a wad of newspaper advertisements announcing the wares of our leading television merchants. Scanning discs, television tubes (neon lamps)—"supply limited; orders filled in rotation"— special amplifiers, etc., are bartered for cash. "Television headquarters" has genuine photoelectric cells (hands off) on display. Incidentally, it is good to know that one can obtain excellent $2 neon tubes for $10 or more. Latest advices indicate that business is brisk. We must conclude, therefore, that such doings give our friend, who was transmitting photographs back in 1907, what is inelegantly said to be a "pain in the neck." Apparently Barnum has been surpassed in showmanship, but he still remains the greatest statistician.

Light Sensitive Cells

The Elster and Geitel cell is the forerunner of the modern alkali metal photoelectric cell. Sodium, potassium, etc., was deposited within the spherical bulb which previously had been silvered to make a good electrical connection with the platinum negative terminal. The



Elster and Geitel Cell.

anode provided was a sealed-in filament. A spark passed through the cell in an atmosphere of hydrogen converted the metal to a sensitive hydride. The hydrogen was then pumped out and an inert gas introduced within the bulb. A current of 4 microamperes was obtained from potassium hydride with feeble sunlight falling upon the cell.

Readers will find this selected bibliography of value in gaining a comprehensive knowledge of phototelegraphy and television:

Armagnat, "Phototelegraphy," Smithsonian Report for 1908. (Out of print.)

Baker, "Wireless Pictures and Television." New York, Van Nostrand; 1927.

Ives, "Phototelegraphy." Ency. Brit. 13th ed.; 1927.

Martin, "The Electrical Transmission of Photographs." N. Y., Pitman & Sons; 1921.

Reports on Television, Bell System Tech. Jour.; Oct., 1927.

A Short Wave Adapter for A. C. Receivers

By G. M. BEST

THE short wave adapter has received considerable publicity in recent years, and there are so many good short wave kits, with appropriate circuits to suit, that it is a simple matter to construct one to work with any factory-built or home-made set. However, with one or two exceptions, the use of a short wave adapter with receiving sets employing a.c. tubes has received no attention, and in view of the fact that the a.c. receiver has practically supplanted the storage battery set insofar as new receivers are concerned, a few pointers on a.c. short-wave adapters should prove useful.

The only real difference between the conventional short wave adapter for d.c. sets, and its a.c. equivalent is in the type of tube used, and the connections between the tube and the receiving set. As practically all factory-built a.c. sets use a type 27 a.c. tube, with a heater element and cathode, a five-prong socket is required in the adapter, with four connecting leads between the adapter and the set instead of three as for the d.c. sets. The circuit which proved to be most satisfactory is shown in Fig. 1, the adapter consisting of an aperiodic antenna coupling coil, a tuned secondary, with .00015 mfd. tuning condenser, and a fixed tickler coil, with .00025 mfd. tuning condenser in series to act as a regeneration control. One of the popular makes of short wave plug-in coil kits was used, so that three sets of coils could be used, to cover a wavelength band from 15 to 125 meters, and higher if need be, since other coils for waves above 125 meters are also available.

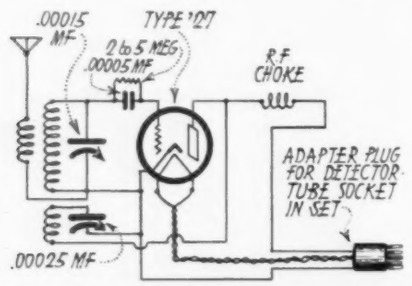


Fig. 1. Circuit of A. C. Short Wave Adapter

The two tuning condensers were mounted on a panel 7 x 12 x 3/16 in., with a baseboard 7 x 11 x ½ in., providing ample room for all the apparatus. The secondary tuning condenser is mounted at the right, as seen in the picture of the set, and the tickler condenser at the left. The plug-in coil mounting is placed directly in back of the tuning condenser, near the rear of the baseboard, and the tube socket on the opposite side.

A five-prong cushioned socket should be used, so as to avoid microphonic noise due to vibration while tuning. The socket has five soldering lugs or binding posts, two of which are marked *H*, one marked *K*, and the remaining two *G* and *P*. The two terminals marked *H* are the heater terminals, to which are brought a connection from the 2½-volt filament winding of the power transformer in the receiving set. The *K* terminal is the cathode, or sheath surrounding the heater, and corresponds to the negative filament connection in a d.c. receiver. The *G* and *P* terminals are the grid and plate respectively, the same as for the d.c. models.

The .00005 mfd. grid condenser is mounted on the baseboard between the tube socket and the coil mounting, and was of the variable mica type so as to pick the best capacity for the particular tube used. It has a minimum capacity of .00003 mfd. and a maximum of .0001 mfd., and has grid leak clips to hold the grid leak in place.

The *K* terminal is the common point for one side of each tuning condenser and ground, as can be seen in Fig. 1, while the wires to the heater have no connection to any part of the adapter. The output of the detector goes through a radio frequency choke, and then through a flexible connection to the receiving set, where the current passes through the primary of the first audio transformer. To make the connection with the receiving set, two twisted pairs of wires are required, one pair for the heater, and the other pair for the cathode and plate connections. It is advisable to have the latter pair twisted as well as the pair for the heater, as a certain amount of a.c. hum will be picked up from the heater pair if the other two wires are not twisted together. The heater wires should be at least No. 18 stranded. The cathode and plate wires may be smaller, as the current carried by them is small.

To connect the adapter to the receiving set, the base of a burned out '27 tube is required. This ought to be easy to obtain from the nearest radio dealer, as there were plenty of burned out ones during the first few months the a.c. sets were on the market. Remove the bulb from the base, and unsolder the old connecting wires, except the grid wire, which will not be required. In order to avoid confusion, a diagram of the a.c. tube base

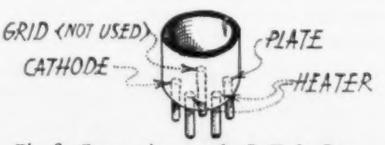
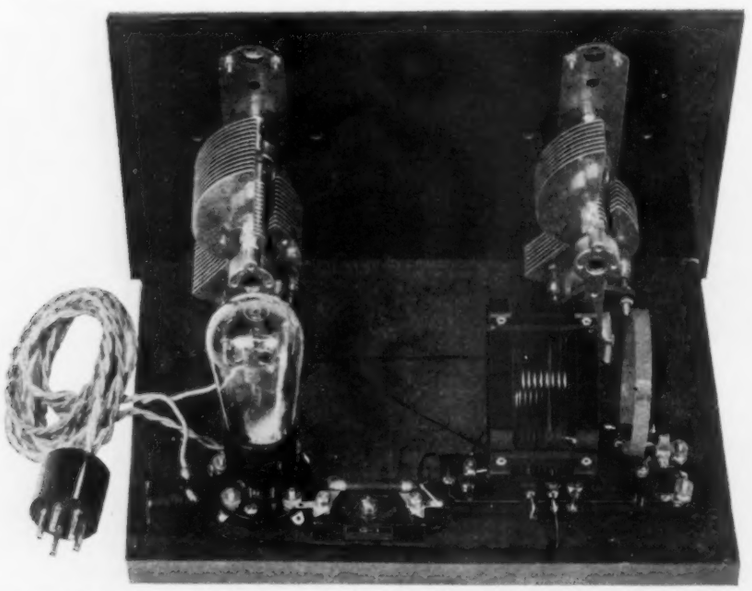


Fig. 2. Connections to A. C. Tube Base

is shown in Fig. 2, looking down on the base as would be the case when inserting the flexible leads from the adapter, prior to soldering them. If there is any doubt about the matter, insert the tube base in the a.c. socket in the adapter, and mark the prongs on the base in accordance with the terminal markings of the socket.

Having finished the connections to the adapter plug, the plug can then be inserted in the detector socket in the a.c. receiver, and the '27 detector tube in turn placed in the socket of the short wave adapter. The r.f. tubes in the broadcast receiver will not be used, but should be left in their sockets in order

(Continued on Page 43)



Rear View of A. C. Short Wave Adapter, Showing Flexible Connection to Receiver

A Selective Screen-Grid Receiver

Directions for Building a Five-Tube Set Which Uses Auto-Transformer Coupling in the R.F. Stages

By FRANCIS CHURCHILL

MUCH trouble has been experienced in working with screen-grid tube receivers because of poor selectivity when using standard circuits. Actually the selectivity per stage is good, but in comparison with the amplification, the selectivity seems to be poor. Probably the lack of regeneration also accounts for it. The amount of regeneration in a r.f. amplifier using ordinary tubes is generally very great when receiving distant stations, so very good selectivity results. With the screen-grid tubes a special circuit is necessary.

The circuit shown in Fig. 1 was selected as having good theoretical possibilities. It consists of two stages of screen-grid tubes with auto-transformer coupling and a special regenerative detector. The auto-coupling gives a high plate circuit impedance without oscillation.

Ordinary transformer coupling has a low primary impedance which would mean that very little of the amplification of the screen-grid tube was being utilized.

For example, if the primary impedance was 5000 ohms, a common value, the maximum gain per stage would be from 6 to 10, which is no better than that obtainable from ordinary tubes. If, on the other hand, tuned impedance coupling is used, the gain is good, varying from 30 to 50. The plate load impedance may be as high as 150,000 ohms for a fairly efficient condenser and coil when using impedance coupling. The trouble with this arrangement is oscillation, as even with extreme care in shielding, two stages are liable to oscillate, especially when using a regenerative detector.

Auto-transformer coupling is a good compromise. In this, the plate lead is tapped into the tuned coil so there is no extra plate or primary winding. Closer coupling is obtainable so that the external plate impedance facing the tube is higher than when using a separate plate coil. This means more amplification. Since there is a voltage step-up in the auto-transformer when the plate lead is tapped in below the grid end of the coil, the overall amplification is still good. The tendency towards oscillation is reduced and so the problem of shielding is

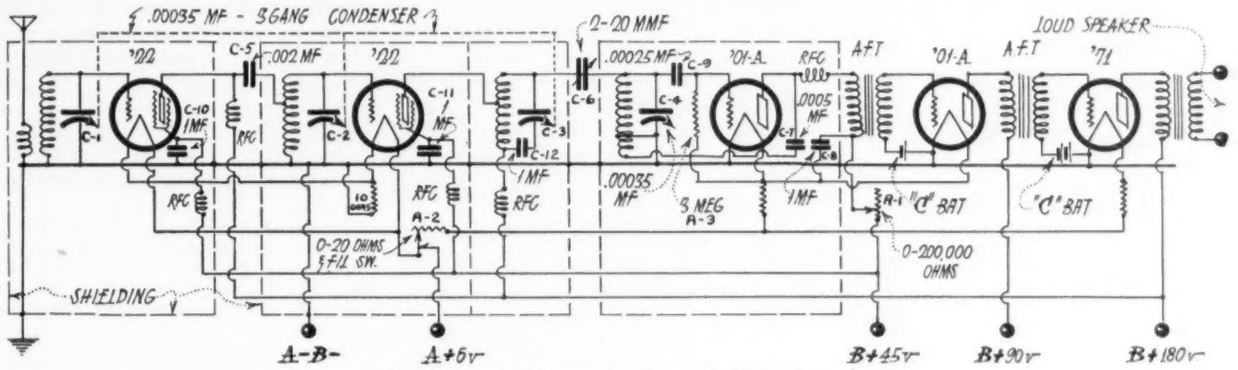
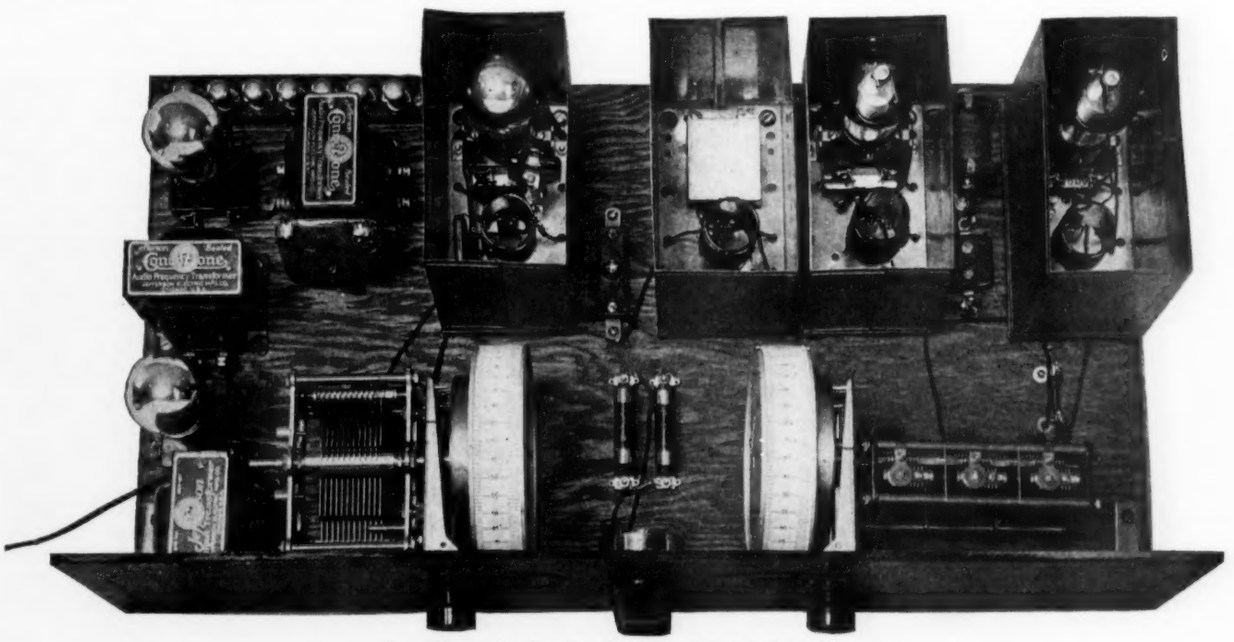


Fig. 1. Circuit Diagram for Screen-Grid Receiver



Top View, showing Baseboard and Panel Assembly

simplified. The receiver shown in the picture has copper cans 3 x 6 x 5½ in. for each stage or tuned circuit. The variable condensers are not thoroughly shielded from each other, although the three-gang condenser has grounded end plates between each set of stator plates.

These copper cans may be made of either copper or aluminum of sufficient thickness to be self-supporting. The tops and bottoms fit like ordinary can covers. The coils may also be constructed by winding 100 turns of No. 30 enameled wire on a cardboard or bakelite tube of 1¼ in. diameter and 2 in. long. The primary of the first transformer and the tickler of the last one consists of 20 turns of the same size wire spaced about ⅛ in. from the filament end of the main winding. The plate tap should be taken about three-fourths of the way up on the coil so that there are about 75 turns in the plate winding section. This means that the impedance of this winding will be about one-half of the tuned circuit impedance, so good amplification is still obtained.

The reason for using coils of such small dimensions was because of the rather small shield cans. A compromise between losses in the coil due to small wire and losses due to having a large coil too near the sides of the shields has to be made. Nearly any r.f. transformer of rather small dimensions may be used in this receiver by soldering in a plate tap as described above.

The detector circuit has two tuned circuits coupled together through a very small capacity C_6. This arrangement increases the selectivity at least 25 per cent, besides isolating the regenerative detector from the plate circuit of the second r.f. amplifier. This latter effect allows better control of regeneration without a tendency to throw the r.f. amplifier into oscillation. The use of a regenerative detector allows excellent dx reception besides increasing the selectivity. The dx reception ability of the Browning-Drake receiver is well known, and this receiver is something like it but has much more amplification. The coupling condenser C_6 should be variable from 1 or 2 up to 10 or 15 micro-microfarads. The more efficient are the two tuned circuits associated with it, the smaller this capacity can be for the same signal strength. Decreasing the value of C_6 increases the selectivity because of the effective looser coupling between the two tuned circuits. Too close coupling, electrostatic, or electromagnetic, causes a double resonant peak which is undesirable as it gives broad tuning in the detector circuit.

Proper control-grid potential for the screen-grid tubes is obtained by means of filament potential drop through a 10-ohm resistor. This resistance is common to both r.f. tubes, so limits the filament voltage across the tubes to about 3.3 volts when using a 6-volt *A* battery. This means about 2 to 3 volts negative bias on the control-grids, which is about right when using 180 volts on the plates.

For volume control, a 20-ohm rheostat is used in the filament leads to the two r.f. screen-grid tubes. Filament current variation for volume control is quite satisfactory and due to the small inter-electrode capacity of these tubes, the volume on even a nearby powerful station can be cut down to a whisper. With the ordinary A tubes the grid to plate capacity is large enough to act as a good coupling condenser between the circuits so that even when the filaments are turned off entirely, a local station will come through.

The audio amplifier may be of any type. The one used in the receiver shown gave good quality and enough amplification to work a 171 power tube to its limit without overloading the detector. It consists of two stages of transformer coupling using an A and a 171 tube. Because of the high plate current of a 171 tube, an output transformer is desirable to protect the loudspeaker windings from burn-out.

The panel and baseboard layout of the receiver is fairly apparent from the picture so no special details are given. The experimenter would probably use available parts anyway. The arrangement shown is easily and quickly wired up and by the use of a wooden panel, the drilling job is made easy, which is important when drum dials are used. A scroll saw may be used to advantage when cutting out the holes for whatever type of drum dial is used. The supporting plates of the dial assembly used in this set had to be reamed out slightly in order to mount the condensers with a single lock-nut.

Most of the wiring, especially all battery leads, may be run underneath the baseboard in order to obtain a neat appearance. The wiring should be as direct as possible and may be made with any insulated flexible hook-up wire. The frames of the condensers, the shielding cans and the audio transformer cases are all grounded to the —*A* battery lead. The by-pass condensers are mounted underneath the tube sockets and the tuning coils mounted as shown by means of brass brackets. The lower end of the coils have about 1¼ in. clearance from the bottom of the copper cans. The control-grid leads should have small spring clips for connection to the top electrode of the screen-grid tubes.

The r.f. chokes may be made by winding 500 turns of No. 34 or 36 wire on a small spool except for the large r.f. choke used to supply plate voltage to the first r.f. tube. The latter choke should be about 250 millihenrys in value since it is in shunt to tuned plate circuit.

The detector regeneration is controlled by means of a 0-200,000-ohm variable resistance in series with the 45-volt plate supply lead. The by-pass condenser C_8 should be at least 1 mfd. so that the lower audio frequencies will not be attenuated appreciably. This regeneration control has practically no tuning effect so that the variable condenser C_4 setting is practically not affected by changes of R_1.

The filament control for the detector and two audio amplifier tubes is automatic since cartridge type resistors are used. The "on" and "off" switch is part of the volume control rheostat.

In lining up the circuits, the trimmer condensers of C_1, C_2 and C_3 should be adjusted until the received signal is loudest and there are no double settings apparent. The coupling Condenser C_6 should be adjusted for the smallest value which will give good volume on distant reception. For those desiring even greater selectivity and sensitivity the use of a tuned antenna system is recommended.

LIST OF HIGH-FREQUENCY CHANNELS ALLOCATED TO COMMERCIAL STATIONS

The following allocation of high-frequency channels for commercial interests has been approved by the Federal Radio Commission. This includes the assignment of new channels and the reassignment of channels to all existing licensed stations:

Tropical Radio Telegraph Co., 7 frequencies			
6,770	10,450	12,940	17,580
6,785	10,470	12,970	
American Publisher's Committee, 20 frequencies			
7,340	7,820	15,580	15,730
7,355	7,835	15,610	15,760
7,370	7,850	15,640	15,850
7,625	7,925	15,670	15,880
7,640	7,955	15,700	15,910
Robert Dollar Steamship Co., 8 frequencies			
7,430	9,410	14,860	18,820
7,445	10,930	14,890	22,670
A. T. & T. Co., 14 frequencies			
6,755	10,550	16,270	21,060
9,170	13,390	19,220	21,420
9,750	14,470	19,820	
9,870	14,590	18,340	
Radio Corporation of America, 65 frequencies			
6,710	9,450	13,900	18,060
6,725	9,470	13,930	18,860
6,740	9,490	14,800	18,900
6,845	10,390	14,830	18,940
6,860	10,410	14,920	18,980
6,890	10,610	15,040	19,020
6,920	10,630	15,430	20,100
6,935	11,680	15,460	20,180
6,950	13,420	15,490	20,260
6,965	13,450	15,970	20,780
7,400	13,480	16,000	20,820
7,415	13,690	16,030	21,220
7,520	13,720	17,860	21,260
7,715	13,780	17,900	21,300
8,950	13,840	17,940	
8,990	11,950	17,980	
9,010	13,870	18,020	
Mackay Radio & Telegraph, 37 frequencies			
6,815	8,930	13,960	19,540
6,875	8,970	14,680	19,580
7,670	9,070	14,710	19,620
7,655	9,280	14,740	19,740
7,730	10,490	14,770	20,300
7,745	10,810	17,420	20,980
7,760	10,830	17,660	21,380
8,075	13,000	17,700	
8,720	13,030	18,260	
8,850	13,750	18,780	

Radio Grounds for Broadcast Receivers

A Statement of the Requirements and How Best Met, Together with Supporting Data About Determinant Conditions

By HECKERT PARKER

Too much emphasis cannot be placed upon the necessity for a good earth connection in securing good radio reception. Yet the best form of ground is so simple and cheap that experimenters and broadcast listeners are apt to disregard the evidence of authentic data and to try types of grounds which are more elaborate and expensive but not more efficient.

An antenna system functions as a condenser in which the overhead collector wire is one plate and the earth is the other. If either one of these plates is connected to the receiving set through a high resistance less energy can be passed and the signals are correspondingly weak. Therefore the whole secret of success in efficient reception is to provide an antenna system of the least possible resistance.

So much has been published regarding the proper installation of the overhead collector that repetition is here unnecessary. But with the development of receivers which are shielded to prevent pick-up by the parts, especially the r.f. transformers, a good ground becomes imperative for good operation. Yet little authentic information is ordinarily available.

The question of suitable grounds for wired telephone and electrical power installations has been the subject of much experimental and research work for years. Some of this is applicable to radio, especially that part which deals with methods of providing minimum ground resistance. Technologic Paper No. 108 of the U. S. Bureau of Standards contains such data.

Because electric power companies have successfully used water pipes for grounds and because this is ordinarily the easiest way to get ground contact, most broadcast receivers are grounded in the same way. In many cases this form of ground is as good as can be secured. But in other cases water-pipe grounds are of higher resistance than some other form. Thus where the water pipe is equipped with insulating couplings, where it is near the surface, where it runs through soil of high resistance, or where the soil is very dry, a poor ground connection results.

To discourage power companies from grounding to water pipes because of electrolysis and possible life hazard, many water companies put insulating joints between the water meter and the outside main and between the couplings in the street mains. This is also done with gas and steam heat piping which are notoriously poor grounds. Under such circumstances better results can be secured with some form of independent ground.

A separate or independent ground frequently has the further advantage of eliminating much electrical interference which is introduced into the set through the ground wire. Furthermore, the efficiency of a radio pickup system depends somewhat upon the effective height of the overhead aerial above the earth's surface. House pipe systems ramble all over a building, vent pipes extend through the roof, drains and metal roofs are grounded to the pipes, and this becomes equivalent to decreasing the effective height of the overhead aerial as well as affording a pickup system for interfering radiations.

Many forms of independent grounds have been proposed. Great masses of copper have been buried and surrounded with coke or charcoal. Fancy copper cans containing "secret" chemicals have been tried and often found wanting. The power and telegraph companies are ceasing to use large metal plates and cylinders, partly because of the expense and partly because simpler installations are almost if not fully as effective.

The simplest and most effective of these independent grounds is an iron pipe driven six or eight feet into the ground and equipped with a means for keeping the ground moist. The author's experiments have proven that this method is equally effective for a radio ground.

Suggestions as to the kind and size of pipe, depth driven, provision for continuous moisture and an electrolyte in the earth surrounding the pipe, effect of different soils, soil resistances, use of pipes in multiple, etc., as presented here, have been selected out of a great quantity of data which has appeared in various scientific publications. That a common iron pipe makes as good and often better ground than the many elaborate, expensive, or patented devices heretofore considered necessary, has caused public service companies to make many checks to prove it. Most of the data on ground or earth electrodes and soil resistances result from studies of their effects with low frequency currents; but according to observers like J. A. Fleming and the authors of technologic papers on this subject published by the U. S. Bureau of Standards, the earth's surface, meaning the crust of the first 50 feet or so is a better conductor of high frequency currents than it is for low frequency currents.

Resistance to the flow of current from an electrode buried in earth depends directly upon the resistivity of the soil. Changes in the soil will cause changes in the resistivity. Table 1 condenses the results of studies of soil resistances made by the U. S. Bureau of Standards (Technologic Paper No. 108) in 35 cities from Boston, east, to Salt Lake City, west; and from Minneapolis, north, to Peoria, south, covering almost every kind of soil to be found in the United States.

RESISTANCE BY KINDS OF SOIL

TABLE 1

Number of grounds tested	SOIL	Average resistance	Minimum resistance	Maximum resistance
24	Fills, and ground containing more or less refuse such as ashes, cinders and brine waste	14	3.5	41
205	Clay, shale, adobe, gumbo, loam and slightly sandy loam with no stones or gravel	24	2.0	98
237	Clay, adobe, gumbo and loam mixed with varying proportions of sand, gravel and stones	93	6.0	800
72	Gravel, sand or stones mixed with little or no clay or loam	554	35.0	2700

The above resistances were measured between various artificial or independent grounds and some distant check point. Over 75 per cent of these were iron-pipe grounds; but the list included electrodes of plates of copper, iron plates and types of patented grounds. According to Letteu (Gen. Elec. Rev., Vol. 18, 1915) the average resistance of 250 ¾-inch pipe grounds were found to be 15.68 ohms, and concludes that the resistance of pipe grounds is just as low—if not lower—than any of the more expensive forms of electrodes or contacts.

While the materials composing the earth's surface vary in resistivity, all soils owe their electric conductivity, with but few exceptions, chiefly to the presence of moisture. Dry sand or hard rocks are poor conductors, but wet sand and moist earth are fairly good conductors. Sea water, owing to the presence of the salt, is a much better conductor than fresh water. Distilled water has a resistance of approximately 40,000 ohms per inch cube. Fresh water from 500 to 1000 ohms per inch cube according to the mineral and other substances held in solution. But salt water has a resistance as low as 10 to 50 ohms per inch cube. Table 2 is taken from U. S. Bureau of

Standards, Technologic Paper No. 25.

EFFECT OF MOISTURE ON RESISTIVITY OF SOIL—TABLE 2

Per cent moisture (in terms of dry earth)	Specific resistance (ohms per cm. cube)
5.0%	2,340,000
11.1%	237,400
16.7%	13,880
22.2%	6,835
33.3%	5,400
55.6%	4,870
77.8%	5,945

Temperature as well as moisture content causes a wide variation of soil resistivity. In moist earth, as the temperature goes lower the resistance of the soil increases, reaching at zero Centigrade (32 deg. Fahrenheit) a value of 100 to 200 times higher than in warm seasons. The frost line, or depths to which the earth's surface soil will freeze, varies from a few inches to several feet at different localities and latitudes where freezing temperatures are reached during part of the year. A ground contact of any kind should always be placed below the frost line. Table 3 is taken from U. S. Bureau of Standards, Technologic Paper No. 25.

EFFECT OF TEMPERATURE ON RESISTIVITY OF SOIL—TABLE 3

Values below taken with moisture content 18.6% and specific resistance at 20 deg. C. 6260 ohms.

Temperature Deg. C.	Resistance Ohms
18.	224
13.	286
8.5	398
1.5	458
1.	462
0.0	542
−2	940
−5	4340
−15	36200

The increase of conductivity of moist earth at high summer temperatures amounts to more than the increase of moisture during a wet but cooler season.

Table 4 (U. S. Bur. Stds., Paper No. 108) shows the seasonal variation of resistance of the average of eight ¾-inch iron-pipe grounds driven 10 feet into the earth.

SEASONAL VARIATION OF PIPE GROUNDS—TABLE 4

1915 Month	Res. Ohms	1915 Month	Res. Ohms
January	55	October	40
February	55	November	48
March	55	December	52
April	50	1916	
May	43	January	58
June	40	February	58
July	40	March	49
August	37	April	47
September	39	May	42
		June	40

It is readily seen that the electrode must be placed below the frost line and the soil kept permanently moist to insure that the resistance of the ground will remain uniform throughout the year. Even in localities where freezing does not occur, there is the necessity for continuous moisture to insure a low resistance of soil in contact with the electrode or ground. It is stated by Sparks (Jour. IEE, Vol. 53) that unless means are provided to periodically impregnate the surrounding soil with moisture and salt, the resistance of a ground electrode will increase.

Nothing is gained by surrounding or filling the electrode with carbon, as the carbon will not absorb any more moisture than the surrounding soil, and in dry seasons will give off moisture as quickly as the soil. According to investigations of F. A. Fish (Elec. World, Vol. 55 and 58) carbon or charcoal grounds vary in resistance at different seasons more than contacts which do not employ carbon to aid contact with the earth but depend upon direct contact with the soil, and where carbon is used the ground connection resistance increases with age faster than when it is not used. Copper plates and other copper masses imbedded in carbon or charcoal show a higher resistance than iron plates of the same size in direct contact with the soil.

An iron pipe 10 ft. in the earth, moderately salted, is estimated as having capacity to dissipate energy at a rate of 5 to 20 k.w. without increase of resistance due to heating or drying out of the soil. Nothing is gained by placing a copper wire inside of the pipe and using the wire for a conductor to a buried electrode attached, or unattached, to the pipe as the choking effect of the iron pipe considerably increases the high frequency resistance of the wire. If the wire inside of the pipe is connected in multiple with the pipe, the conductivity of the pair is no greater than that of the pipe alone.

Pipe grounds are permanent, at least for a number of years according to J. L. A. Hayden (Proc. AIEE, Vol. 26, pt. 2). Galvanized iron pipe will last from 10 to 25 years (Wolf, G. E. Rev., Vol. 18). Pipe grounds should be galvanized to prolong their life, but not necessarily to reduce resistance, as rust (iron oxide) has no higher resistance than soil and is just as permeable to moisture. Where electrolysis is present, a direct current will cause a film of gas to form on an iron pipe, and this gas will greatly increase the resistance of the ground. This gas will not form on zinc galvanized pipe. A larger pipe will have a greater wall thickness and correspondingly longer life; but the size of the pipe has no practical effect on the resistance of the ground contact.

As in the case of a wire conductor, a radio wave does not penetrate into a good conductor as far as it penetrates into a poor conductor. In the case of the earth's surface, there is considerable penetration of the wave below the surface. The depth a radio frequency wave penetrates into the earth, when its amplitude is reduced to 0.367 of its original amplitude, is shown by Fleming in Table 5.

TABLE 5

Material	Depth Feet
Over sea	4 to 5
Over fresh water	12 to 20
Over damp soil	25 to 100
Over dry soil	140 to 400

Brylinski (The Electrician, London, Vol. 57) has shown that over soil having an average resistivity of 66 ohms per metre cube (a low figure) that a radio wave of 300 metres length would penetrate into the earth's surface about 50 metres, and that 95 per cent of its current density will be in the first 5 metres below the surface.

A pipe just in contact with the earth's surface will have a very high resistance. Values recorded show minimum of 1000 ohms to maximum of 10,000 ohms and over. The natural moisture bearing stratum of the earth offers the lowest path of resistance. This stratum varies in depth from 1 to 8 feet below the earth's surface according to the geological formation of different localities. The resistance of a ground is not reduced by driving a pipe through or beyond the moisture-bearing stratum; but as the resistance will be very high if the pipe is not driven far enough, it is interesting to observe what is a proper depth.

E. E. Creighten (Proc. AIEE, June 1908) shows results which have been checked with other observers. The variation of resistance of five different pipes at every foot penetration into earth is

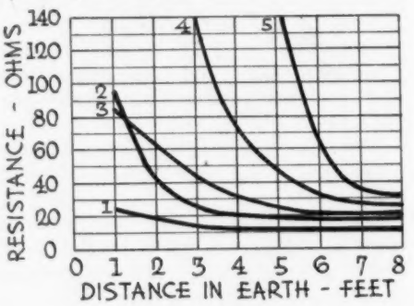


Fig. 1. Variation of Resistance with Depth

shown by curves in Fig. 1. These observations, checked by other observers, show that the resistance of artificial grounds rapidly decreases up to about 6 or 8 ft., at which point the resistance becomes fairly uniform. It can be concluded that a pipe should be driven, or other form of ground buried, not less than 6 ft., nor more than 8 ft., below the earth's surface.

Several observers agree upon the effect of connecting pipe grounds in multiple. The following quotation is from Creighten (Proc. AIEE, Vol. 27): "If several pipes are driven in homogeneous soil, at different distances apart, it is found that the resistance between pipes increases as the distance between pipes up only to about 6 feet distance. For greater distances the resistance is practically constant and independent of the distances between the pipes."

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Data for the Radio Notebook

Including Answers to Questions Addressed to "RADIO'S" Laboratory

This department replaces the former Queries and Replies page, and in addition to containing answers to questions of general interest, a considerable amount of technical and semi-technical information will be included each month. New radio developments, useful data on radio theory and practice, and on subjects allied to radio will appear in each issue. Where personal answer to questions is required, a fee of 25 cents per question or diagram should be sent. Special diagrams, requiring an unusual amount of time to prepare will carry an extra charge, and the correspondents will be notified of the amount of this charge before answer is made.

With several manufacturers announcing new audio transformers in which the plate current is kept out of the primary winding by means of a resistance and bypass condenser, a recent experiment in RADIO'S laboratory is brought to mind. A three-stage amplifier, consisting of a type A, 112-A, and push-pull 210 tubes, received its *B* supply from two *B* power plants, one of 525 volts output, and the other of 200 volts. The latter supplied the *B* power for the r.f. stages, detector and first audio, and the high voltage eliminator supplied only the last two stages. The 112-A tube required 90 volts effective at the plate, for the *C* voltage was only 4½, and to cut the effective voltage from 525 to 90, a 150,000-ohm fixed resistance was placed between the positive 525-volt supply, and the primary of the push-pull input transformer, as is shown in Fig. 1-a. A 1 mfd.

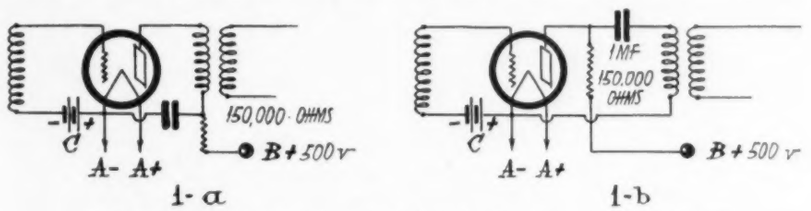

Fig. 1. Methods of Plate Current Feed to Audio Frequency Transformer

bypass condenser between the resistance and the filament was used to provide a low resistance path for the a.c. component back to the filament of the tube, and the resistance limited the plate current to approximately 3 milliamperes. By changing the connections so as to use the circuit of Fig. 1-b, the plate current was kept out of the primary, thus bringing up the low frequencies appreciably, yet without any change in the apparatus used. Some of the new transformers have this resistance and condenser enclosed in the same case with the transformer, and the condenser is so selected that it forms part of a series resonant circuit with the inductance of the primary winding, so as to bring up the low frequencies.

Incidentally, the use of two separate *B* supplies for a receiving set, while not new, is a sure cure for motor-boating. It may seem expensive at first sight, but it permits operating a three-stage resistance, impedance or transformer coupled amplifier at full amplification without having to introduce lossers of any kind to stop inter-stage oscillation. By using a relatively low voltage *B* power unit to supply the tubes ahead of the audio amplifier, including the detector, and then using the high voltage rectifier unit for the last two audio stages only, a remarkably stable outfit will result.

There have been a large number of new power amplifiers this season, most of them using the type 250 tube, and thus making available at a moderate cost an amplifier having a power output of from 4 to 8 watts, depending on whether it is a single stage, or push-pull. This relatively large amount of power is not required by the average home installation, except in cases where a large room is to be filled with sound while there is considerable local noise. Reserve power is always nice to have if cost is of no object; particularly when listening to a symphony orchestra, where the changes in volume are extremely marked. But the greatest use for the new super-power amplifiers will be for the public affairs such as dances and entertainments, where a minimum of five or more watts will be required to supply several speakers.

In November, 1927, RADIO, a high power amplifier employing a 50-watt tube in the power stage, with another tube of the same time as a half-wave rectifier, was described, this amplifier giving an undistorted power output of about 7½ watts. At that time, there were no coupling devices which would permit applying 50 or more volts to the grid of the 50-watt tube, without employing step-up transformers of such high ratios that the frequency characteristic of the amplifier would be poor. However, there are now a number of such transformers, designed expressly to go ahead of the type 250 tube, which are admirably adapted to use with the 50-watt tubes. In Fig. 2 is a revised circuit diagram of the 50-watt tube amplifier, with a type 112-A tube first stage, transformer coupled through one of the new coupling units, to the 50-watt tube. As these coupling units differ in internal connections, it will be our policy hereafter to show such coupling devices as shown in the diagram, with the four connecting terminals marked in the conventional manner.

Several who have built this amplifier have written that the volume output is sufficient to supply their needs, but that the tone quality was inferior to a push-pull 210 amplifier. This is because the plate current of the power tube saturates the core of the output transformer. The way to avoid this trouble is either to use an output transformer designed to carry 55 milliamperes without saturation, or employ impedance-transformer coupling in the output circuit. Here a matter of economics enters into the situation, as the by-pass condenser in the output circuit must necessarily be at least 4 mfd.

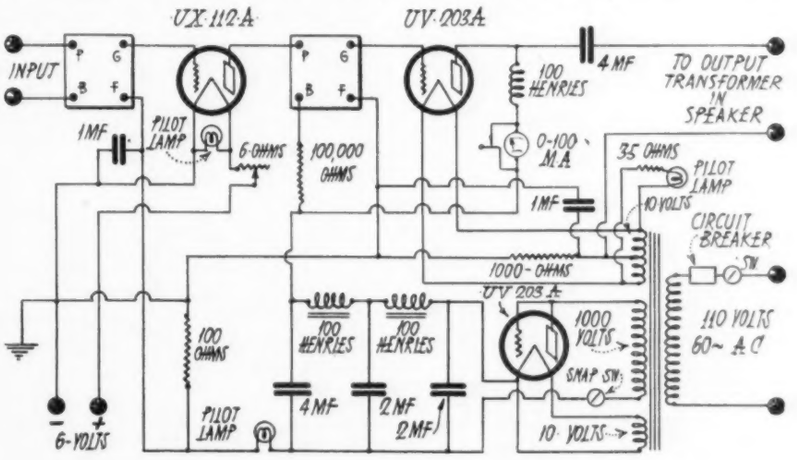

Fig. 2. Revised Circuit Diagram of High-Power Amplifier

in capacity in order not to affect the low frequencies, and must also withstand a continuous voltage of 1000 d.c. Such condensers are expensive, and also take up a lot of room, so that the transformer which will carry 55 m.a. without saturation is the best choice. While those transformers designed to work with the 250 tube have a lower primary impedance than is desirable for the 50-watt size, the reflection losses are not sufficient to preclude their use. If the amplifier was converted into one of the push-pull type, this difficulty with transformer core saturation would be obviated, and at the same time the power output would be practically doubled.

Most of the new talking movie outfits employ a push-pull 50-watt tube amplifier in the power stage, preceded by several preliminary stages, the last of which is a pair of 5-watt tubes, push-pull. To supply the plate power for the last stage, a pair of 50-watt tubes are used as a full wave rectifier, as a single 50-watt tube would not handle the power necessary to supply two amplifier tubes. From four to six loud speakers are fed from this amplifier, through a set of control panels which limit the volume to each speaker to a definite, controllable amount.

The operation of a screen-grid tube as a detector to supply sufficient voltage to actuate the grid of a power tube, thus eliminating the distortion which results from a multiplicity of audio-frequency amplifiers, is indicated in Fig. 3. This is taken from a recent I. R. E. paper by J. R. Nelson. This circuit uses the grid bias method of detection, rather than a grid-leak and condenser, which can not handle the relatively high r.f. voltages which are essential to the success of this scheme.

R.f. potentials of three or four volts can readily be secured from a three-stage amplifier using screen grid tubes. Then by using a high *B* voltage in conjunction with a high plate resistance in the output of the detector circuit, it is possible to secure a detector output of 21 volts or more, which is sufficient to operate a '71 power tube.

Mr. Nelson's experiments showed that adjustment of the negative grid bias between 7½ and 12 volts, and of the positive screen grid between 45 and 67½ volts until a 100 microampere plate current is produced with no input signal gives adequate output at various r.f. voltages up to the tube's limit.

In spite of the detailed description of the special output transformers required with electro-dynamic speakers, which appeared in April, 1928, RADIO, we still receive inquiries as to why some particular type of push-pull amplifier refuses to work satisfactorily with the Magnavox or Jensen speakers. Since that particular description was published, a number of transformer manufacturers have announced push-pull output transformers having primary windings designed to fit the 71-A and 210 tubes, and with a secondary winding designed to match the impedance of the moving coil in the electro-dynamic speaker, this impedance usually being about 10 ohms, at audio frequencies.

Practically every electro-dynamic speaker on the market has an output transformer built in the base, the primary of the transformer usually being of an impedance such that it will fit the average power tube. When using this speaker with a push-pull amplifier, the transformer in the base of the speaker should be abandoned, and the special output transformer should be used in its place.

Most of these speakers have a pair of flexible leads coming from the moving coil to a terminal strip, where they are soldered to a pair of wires leading to the secondary of the output transformer. The latter pair of wires should be unsoldered and pushed back out of the way, while the new pair of wires coming from the secondary of the push-pull output transformer should be soldered in their place. Do not connect the secondary of the push-pull output transformer to the input leads of the speaker as normally connected at the factory, or a hopelessly wrong impedance relation will be set up, which will result in only a feeble squawk being heard from the speaker. Incidentally, most of the output transformers which are furnished with electro-dynamic speakers will saturate on plate currents in excess of 30 milliamperes, so that when using them with the type 250 tube, an impedance coupled output with 4 to 8 mfd. in the coupling condenser, and a 100 henry choke to bypass the plate current of the tube will give improved results at the low frequencies.

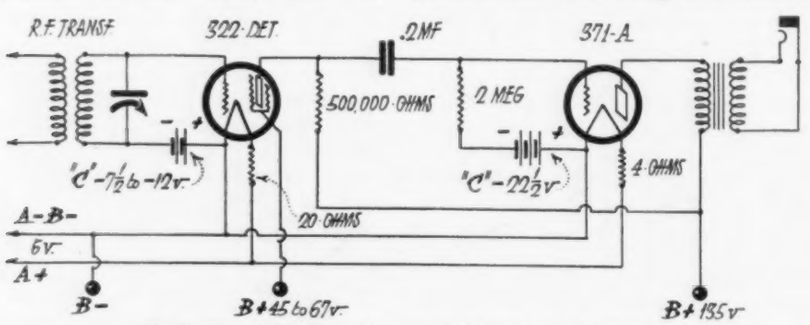

Fig. 3. Circuit for Use of Screen-Grid Tube as a Detector

One of the most interesting of recent developments in the electrical industry is the Westinghouse Televox, an automatic device which answers the telephone and responds to sounds transmitted through the usual audio channels of telephone systems. While this device is as yet confined to wire telephone channels, its adaptability to radio uses makes it a fascinating subject for experimenters.

The latest model consists of a mechanism to emit articulate speech of good tone quality, and a number of relay devices which are operated by the person at the distant end of the circuit by means of a series of whistle signals. If installed, for example, in an automatic substation of a power company, where there are no attendants, it can be so adjusted that if a circuit breaker trips automatically, or a machine overheats, or if any of the various devices in the plant get out of adjustment, the Televox is automatically started, and the voice of the mechanism speaks to the telephone operator, giving her the number of the telephone at the main office of the power company. As soon as the dispatcher at the main office hears the Televox voice, he blows a blast on the proper whistle, and proceeds to question the machine by further whistles, as to what has happened. The answers to these questions are sent by the Televox by means of a buzzer code which the dispatcher understands.

The most ingenious part of the device is the means of producing speech of good quality. A piece of moving picture film about 20 ft. long is spliced so as to make an endless loop, and on this film several sentences are recorded by the photographic process. The sound appears in the form of closely-spaced lines of various shades and widths, and since the film is endless, the sentences are spoken over and over again until the machine is stopped. A selecting mechanism in the Televox lights one of a group of lamps depending upon the sentence desired, and the image of the light is projected through a narrow slot onto the speech record through which it passes to a photo-electric cell. The photo-cell passes current directly proportional to the amount of light falling on it, and as the lines on the film pass in front of the light, the corresponding change of currents which take place in the photo-cell are amplified through a three-stage amplifier to a volume sufficient to operate a small loud speaker. This speaker is placed in front of the telephone transmitter and is heard by the person at the

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Radio Control of Ontario's Forest Fires

By JAMES MONTAGNES

RADIO and the airplane play important rôles in the protection of Ontario's vast forest wealth. The airplane, soaring high above the lake-studded forest regions north of Lake Superior, spots the smoke that tells of the fire. The signals from the short wave radio sets flash the news from post to post, and summon by airplane, railroad and canoe, the fire fighters and their machinery.

On such a system was Ontario's network of forest radio stations founded last year. This summer the chain grows. A vital part in the program of the Forestry Branch of the Ontario Department of Lands and Forests, the radio has already proven of immense value in expediting instructions to forest rangers, airplanes and fire fighters.

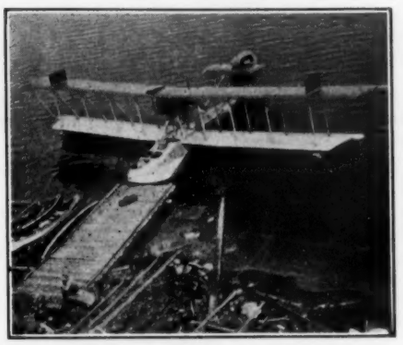
Despite the fact that last year was a wet one, and only a few fires of importance were encountered in northern Ontario, especially in the Red Lake Mining District, nevertheless the transmitter at Gold Pines was used on one memorable occasion to flash to Sioux Lookout the report of a serious conflagration. As the news of the fire reached the headquarters, preparations were made to send assistance by airplane. But the operator went on to say that Gold Pines and neighboring territory could supply all the fire fighters and fire-fighting machinery necessary.

From a radio standpoint, therefore, last summer was not a good year. Evidently the department considers the network to have done good work, for from four stations in use last summer, the service will be strengthened to nine.

Seven of the stations are in what is called the Red Lake Mining District. Sioux Lookout, on the Canadian National Railway mainline, is the headquarters of the radio network. From there the other six stations radiate in north-easterly and north-westerly directions. At Bold Pines, 70 miles northwest of Sioux Lookout, is station 9BH. Another forty miles farther on at Red Lake is 9BD. Then still farther at Woman Lake is 9BG. Ten miles from there, at Narrow Lake, will be one of the new stations, which has not yet received its call letters.

In the Thunder Bay territory, a station will be erected at Savant Lake, a little better than 50 miles distant northeast from Sioux Lookout. Another will go up at Fort Hope, 70 miles further northeast. Then two stations are planned for Lake Timagami and Maple Mountain, near the newly settled Clay Belt north of North Bay. These will not be in touch with Sioux Lookout, however.

The stations are chiefly for the use of the Forestry Service. Last year, however, they carried a considerable amount of traffic for the prospectors in the territory, which is one of the biggest mining fields in Canada. A total of 52,000 words were handled during the season, and this year in order to cope with the expected traffic from mining men, a nominal charge is to be made for important messages. Many of the prospectors took advantage of the free service last year, sending radiograms of little importance. The four stations at Sioux Lookout, Gold Pines, Red Lake and Woman Lake, will handle some of this traffic this year, when the service is not required for the forestry department.



Seaplane at Red Lake, Ontario

The transmitters are fifty-watt outfits, except at Sioux Lookout, where a 250-watt set is installed. Three 75-watt sets will go north this spring, one to replace the set at Red Lake, and the other two for Savant Lake and Fort Hope. All transmitters function on a wavelength of 100 meters, and it is thought probable that 50 meters will be tried this season. For power supply they use small farm lighting equipment.

Further improvements for this summer include the installation at Gold Pines and Sioux Lookout of two portable transmitters and receivers at each post, with power supply from a small generator. It is proposed to use this apparatus for emergency work. The planes which bring the fire fighters to the fire, will also carry the radio apparatus and an operator, and thus the progress of the fire fighting can be reported direct from the scene of action.

Sets for use with airplanes are also being made, and will receive tests this summer, if permission can be obtained from the aeronautical branch at Ottawa. It is necessary to mount a small wind-driven generator on the wing struts, and permission to do this must first be obtained.

The apparatus has to be as light and portable as possible. Both transmitters and receivers, as well as the power plants are built with this in view. The reason for this is obvious when it is learned that airplanes have to take in all the equipment. Also the sets are practically fool-proof, which makes them more efficient. The outfits seen at the Ontario Parliament Buildings, where all apparatus is assembled and designed, show them to be very up-to-date, with all the improvements that a short wave semi-commercial transmitter and receiver should embody.

AIR LINER CALL LETTERS

By JAMES MONTAGNES

Now that airplanes carry passengers as regularly as ships, and Europe is criss-crossed by airways, the air liner is as fully radio equipped as a transatlantic liner. To the radio operator attached to the plane will come orders from his headquarters, addressed to his plane, or he can communicate with land. In either case, to identify himself with as little waste of time as possible, he uses call letters in the same way that ships at sea and broadcast stations on land are identified.

The International Bureau at Berne, which looks after assigning all ships, coast stations, warships, etc., with call letters has devised a list for designating airplanes. The list calls for all airplanes to have five-letter calls. The first letter is the nationality designation, and the other four letters the registration mark of the airplane. Thus when an airplane bears on its wings FADAY, that also is its call letter for radiotelegraphy.

Since there are more nations than letters in the alphabet, the nationality letters in many cases are the same, but the next four letters will reveal the nationality. Where two or three countries have the same nationality letter, as is the case with Hayti, Hungary, Holland and Siam, whose letter is H, the first letter for the group of four letters is different. Thus Hayti can use all four letter combinations starting with H, Holland with N, Hungary with M, and Siam with S. Thus a Dutch airplane can be registered as H-NADU, and its call signal will be similar.

French airplanes plying the regular air lines, such as Paris-London, Paris-Amsterdam, Paris-Berlin, are using call letters which coincide with their registration mark on the wing. Thus FADCA, FADFQ and FAEAV are all planes on these routes, answering to these radio calls. French calls start with the letter F, followed by the four-letter group which starts with a number of different letters. Where the air liner is

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With the Amateur Operators

SHORT WAVE STUFF

By VERNON L. HARVEY

Answering the question "What power, ohm?" has usually brought a flood of questions as to the type of tube, circuit, power supply, etc. The following dope is given in hopes of thoroughly satisfying everybody.

At this station, the tube is of primary interest, being water-cooled. The tube in use at 6 BCH is the development of Mr. James F. Lee of Stockton, and is identical with some supplied to the Federal Telegraph Company. While not so well known to the amateur fraternity in general, Lee is considered one of the cleverest tube men in the business.

As proof of this, the tube at this station oscillates freely on inputs of 40 watts at a wavelength of 10 meters and with full output. Lower input or higher frequencies have not been tried yet, but the performance of the thing at ten meters indicates that it will stand up under nearly full input at this wave.

Doing duty as a "skyplow" the tube is run with a minimum input, and for all ordinary work does not exceed 300 watts. This means that for communication with parts of Asia, the United States and Oceania under favorable conditions no trouble is experienced in working these. However to get into Europe, Africa and South America it is necessary to use a greater input, for anything approaching consistent contacts.

The secondary of the high voltage transformer is tapped in 500 volt steps each side of the center tap to give a greater and more satisfactory variation of input power. Using 980 watts input, no difficulty is experienced working practically everything that comes through and in weather that would be impossible for the low power set to work at all. As a rule, however, the thing is operated with only a thousand volts on the plate which has been found to give consistently satisfactory results. No great difference is noticeable in signal strength when communicating with sixes between 300 and 1000 watts input. The slightly increased strength does not seem to be worth while except in cases of bad QRM when a quick QRO is FB.

The circuit in use is the faithful old Hartley which functions beautifully with the water-cooled tube. Due to the fact that overloads do not cause any great changes to take place in a tube when the plate is water cooled, circuits and adjustments are permissible which would not be possible where the plate was subjected to physical changes such as would occur in an air-cooled tube. If the grid current in kept within sane limits and a decent antenna system is used the water-cooled tube will always be steady.

As can be seen from the picture, the set is built around a wooden frame 5 ft. high by 24 in. wide by 24 in. deep. The upper compartment contains the oscillator, the lower the power supply. The tube is mounted on plate glass as are the meters on the front of the set, the entire upper part being completely enclosed in glass to keep out dust, fingers, etc., hi! The grid condenser is a Cardwell air spaced, fixed. The remainder of the apparatus is home made except, of course, the tubes and meters. The condensers are of .0005 mfd. capacity and with quarter inch spacing between the rotor and stator plates. Unfortunately the condensers do not show. The tuning condenser is mounted at the top of the set suspended upside down while the plate stopping condenser is a duplicate also variable but fixed to all practical purposes. Controls from the condensers are brought to the front panel via an 8-in. glass rod which eliminates hand capacity effects.

Transmitter at 6 BCH, Stockton, California

A grid meter is considered essential for the good of the tube, and is connected in circuit at all times. If the grid current is allowed to rise abnormally the signal will be as unsteady as would be the case if the plate heats and cools. It is simple to adjust the oscillator for good input to output ratio and yet have an excessive grid current which would not manifest itself in the plate and antenna meters. With this particular arrangement, full efficiency is realized only with a low value of grid leak, on the order of 3000 to 5000 ohms. Burning the filament at its normal rating of 10 volts and with a low grid leak the grid and plate meters will show excessive currents. The filament is then dropped to 9½ volts and normal readings are restored with only a slight decrease in antenna current readings.

The only bands in regular use at present are the 20 and 40 meter channels. QSY from 20 to 40 is rapid and simple. Simply change the tuning condenser settings from near maximum to near minimum for 40 and 20. No doubt many will not approve of this, bringing up the old LC ratio stuff but tests over an extended period of time show no difference between this method and using a different coil for each band, as regards signal strength, steadiness and general all-around efficiency. At any rate it saves a coil and simplifies the thing just that much, which should help.

The power is taken from the regular 110-220 service, working the plate transformer from 220 and the filament and mercury arc from each side of the neutral. A few turns are taken around the high voltage transformer leg and placed in series with the primary of the filament transformer. This is tapped every turn and to readily change the filament compensation they are brought out to contacts on the front of the panel. With some types of commercial transformers such as are ordinarily obtained from the power companies there is not enough room for even a few turns around the core in which case, of course, one would have to use an iron core inductance, tapped. However, the choke will not prove as satisfactory as the former, due to the fact that the choke will sometimes

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A LOW POWER PHONE TRANSMITTER

By L. T. CARLSON

To build a stable radio telephone transmitter for the amateur bands requires a little ingenuity and a strict adherence to a few simple rules that apply to an ordinary oscillator together with a knowledge of common audio-frequency circuits. Audio-frequency data are so common and accessible and have become such important factors in the receiving industry that the ordinary layman has little or no difficulty in building an audio-frequency amplifier with good characteristics. Therefore it is only necessary to apply one's knowledge of a stable r.f. oscillator with that of audio-frequency circuits to make a good modulating unit that will modulate the oscillator properly.

The diagram in Fig. 1 shows the transmitter divided into four parts: oscillator, power-amplifier, modulating unit, and the speech amplifier. We will first consider the oscillator.

The transmitter incorporates a master-oscillator together with its power-amplifier, which was chosen because of its extreme stability and its ability to stay in adjustment under heavy modulation. The oscillator makes use of the Hartley circuit, with a UX210 as its source of oscillations. The values are all given for the 150 meter band, but can easily be converted to any band desired. The circuit is arranged for parallel feed with a voltage of approximately 500. The grid condenser has a value of .004 mfd. shunt, with a grid leak of 5000 ohms capable of carrying at least 25 mills. The tank circuit is tuned with a .001 mfd. condenser associated with an inductance composed of 12 to 16 turns of No. 18 wire or larger. The blocking condenser C-1 is also .004 mfd., the writer believing in ample capacity in this case. All circuits are metered, including plate, tank, and grid circuits. The importance of having all circuits metered so as to know exactly what is going on cannot be over-estimated, especially when supplying continuous oscillations that are to be modulated.

The power-amplifier is coupled to the master oscillator through a .004 mfd. condenser and biased through a radio-frequency choke with 90 to 100 volts. The high frequency is by-passed around the batteries by virtue of the condenser C_{14}. It will also be noted that the plate of each tube is fed through two small chokes *2* and *3* whose function is to keep down any parasitic oscillations that might develop. Too much importance cannot be placed on these chokes, especially when using a number of tubes in parallel. The tank circuit is identical with that of the oscillator excepting that the inductance is heavier but the capacity associated is the same. The circuit is neutralized by means of condenser C_8 which is of the midget variety. The circuit sometimes needs very little neutralization, but it is best to have a positive means at hand so that it can be done conveniently, in fact for undistorted output is absolutely essential.

The modulation system is simple, consisting of the Heising constant current choke and three 210s in parallel with their respective chokes in the plate leads. The grids are biased with a battery voltage of 50 through 10,000 to 20,000 ohm grid-leak.

The speech amplifier is sometimes left out in amateur telephone sets, but should be used for undistorted modulation. The amplifier consists of two stages using a 201-A in the first stage and a 112-A in the last stage, with tubes coupled by high inductance chokes of 100 henrys or more. A high inductance should be used in conjunction with a 201-A tube because of its high plate impedance. The 112-A tube is biased through a ¼ meg. grid-leak to the correct value, and the blocking condenser for each of the tubes is 1 mfd. The transformer T_1 is hard to procure, but is important for good modulation; in fact the quality and fidelity of modulation depends almost entirely upon this transformer providing that it is associated with a good microphone and a straight line amplifier. The transformer that should be used can be had factory made by several of the largest transformer manufacturers, although a reconverted audio transformer will work with fair results. The best transformer is one whose secondary impedance is 50,000 ohms or more and whose primary matches the microphone fairly well, or about 200 ohms.

In adjusting the oscillator so as to emit a pure, steady wave it is most important to see that the tube is not overloaded and for perfect modulation see that the plate voltage and tank current curve is as nearly straight as possible. When modulating, the voltage rises to nearly, and sometimes over, twice its value. Therefore, to get really good modulation the oscillating current must vary in proportion to the plate voltage. The oscillator feeds two 210s and consequently can be operated very much under its rating and still get the voltage swing necessary to operate the amplifier to capacity. The best adjustment for the oscillator is about 40 to 50 mills on the plate, getting the tank current to as high a value as possible with this value of plate current. The grid current should run about 5 to 10 mills. These adjustments are all made with tap No. 1 two turns below the plate tap with the plate voltage on the power-amplifier disconnected, but the oscillator in an oscillating condition. If the circuit needs neutralizing, which it probably will, there will be a small amount of tank current present in the amplifier circuit. This current will be in the neighborhood of one-tenth ampere so at this point it is best to substitute an 0 to 100 mill thermo-coupled meter in

(Continued on Page 44)

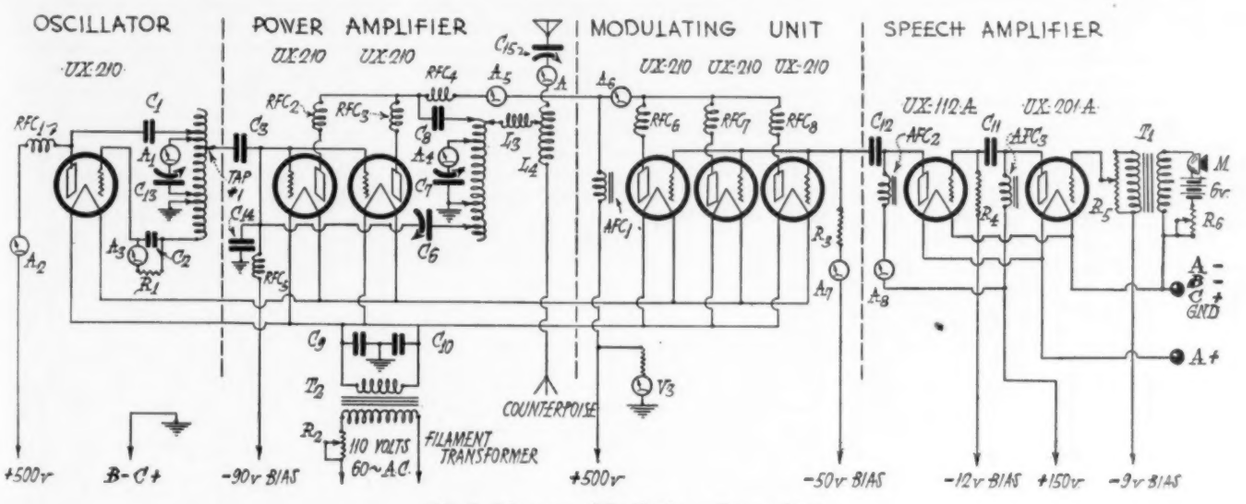

Fig. 1. Diagram of Radiophone Transmitter

L_1=12–16 turns No. 18 or larger on 6 in. form.
L_2=12–16 turns No. 16 or larger on 16 in. form.
L_3=30 turns No. 22 on 3 in. tube.
L_4=18 turns No. 16 on 6 in. form.
C_1=.004 mfd.; mica condenser.
C_2=.004.
C_{13}=.001 mfd.; any good loss variable.
C_3=.002 mfd. mica condenser.
C_4=Mica condenser.
C_5=Mica condenser.
C_6=Mica condenser.
C_{10}=Mica condenser.
C_8=Midget variable.
C_7=.001 variable condenser.
C_9=.004 mica condenser.
C_{11}, C_{12}, C_{14}=1 mfd. 500-volt test.
C_{15}=.00025 variable condenser.
R_1=5000 ω to carry up to 25 mills.
R_2=Bradleystat.
R_3=10000–25000 ω Lavite or equivalent.
R_4=¼ meg. grid-leak.
R_5=500,000 variable resistor.
T_1=Microphone transformer.
T_2=100-watt fil. transfomer.
AFC_1=100 H. filter choke.
AFC_2=100 H. or over.
AFC_3=250 H. or over.
RFC_1, RFC_4, RFC_8=300 turns No. 24 on 3 in. tube.
RFC_2, RFC_3, RFC_6, RFC_7, RFC_8=20 turns No. 24 on 1 in. tube.
A_1=0–5 or 0–10 Thermo-couple radio frequency.
A_2=0–100 mills. A_3=0–50 mills.
A_4=0–10 Thermo-couple radio frequency.
A_5=0–300 mills. A_6=0–300 mills.
A_7=0–10 mills.
A_8=0–25 mills.
V_1=0–15 A.C.
V_2=0–10 D.C.
V_3=0–1000 D.C.
M=1- or 2-button carbon microphone.

Radio Kit Reviews

THE SARGENT-RAYMENT SEVEN

An interesting account of the feed-back problems which were met in the design of this kit and of how they were solved.

By E. M. SARGENT

The Sargent-Rayment Seven has been designed to take advantage in the most efficient manner of the screen-grid tube's absence of capacity-coupling and thereby to give better selectivity and greater sensitivity than is possible with any of the older types of three-element tubes. Notwithstanding all the ingenious methods which are used to control the feed-backs caused by capacity-coupling between the grid and plate, the fact remains that any gain due to multi-stage r.f. amplification has either been nullified by feed-backs and overwhelmed by oscillatory howls and squeals or killed by "lossers." The first practical method to eliminate these troubles is that offered by the four-element tube with its grounded shield-grid element between the signal grid and the plate.

But even this new tube does not eliminate some of the other feed-backs which may also provoke oscillation. Consequently many months of experimenting were necessary in order to construct an r.f. amplifier wherein practically all feed-back is stopped. The object of this story, after discussing the means whereby 10 k.c. selectivity was accomplished, is to show how the feed-backs have been eliminated in this new kit.

The two factors which govern selectivity are the amount of amplification per stage and the excellence of the tuning circuit. The influence of the first factor is so well-known as to require no discussion here. The great amplifying ability of the screen-grid tube can be utilized with the desired selectivity only by care in the selection of the coils and condensers in the tuning circuits so as to give better selectivity than is necessary with tubes of less amplifying ability.

The importance of tuning circuit design may be illustrated by Fig. 1, which depicts the resonance curve of a tuned circuit. A receiver gets the most energy from its antenna when it is exactly in tune with a station, as indicated at *1.0*, the high point in the curve of a circuit tuned to 1000 k.c. (300 meters). The horizontal axis shows the kilocycle markings on each side of a 1000-k.c. channel. The vertical line shows the proportional drop in energy as the tuning deviates from resonance.

Thus at 990 or 1010 k.c. the full line curve shows that ¼ as much energy is received as at 1000 k.c. If the first tube in the antenna circuit has an amplification factor of 5, it

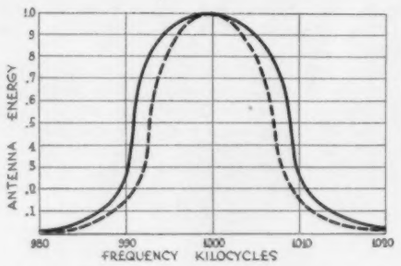

Fig. 1. Resonance Curve of Tuned Circuit

delivers 1.25 units of energy with which to contend at the input to the second tuned circuit, as compared with 1.0 unit at the first tuned circuit. This means that the signal is being tuned in rather than out. It becomes stronger and stronger as more tubes and circuits are added.

If the tuned circuit has a sharper resonance curve, as shown by the dotted line in Fig. 1, the energy is cut to 1/6 instead of ¼ its original amount when the frequency is shifted 10 k.c. When this is amplified 5 times by the tube, there are .833 units in the input to the second tuned circuit. This is less than in the antenna circuit and the addition of a sufficient number of similar tuned circuits would lead to the practical elimination of the local signal in the last tube. So the first element in solving the problem of selectivity is in the proper design of the tuned circuit.

The "cut-off" of a tuned circuit depends upon the efficiency of its coil and condenser. A large size of enameled wire, space wound on a form having low loss and of about equal length and diameter, gives an efficient coil. Good insulation and high plate conductivity reduce condenser losses. The average coil and condenser combination have a critical point at about 12 kilocycles where the circuit has more cut-off than the tube has amplification. This explains why the average set does not cut off at 10 k.c. and why no set is sharp enough to eliminate heterodyne whistles, which differ only 2 or 3 k.c. from the received wavelength.

The coils and condensers used in the Sargent-Rayment Seven have their critical point at about 8 k.c.

The number of tuned circuits needed to effect 10 kilocycle selectivity depends upon the amount of amplification desired on the weak signals. Each added circuit increases the ratio between the weak signal that is being amplified and the strong one that is being minimized. After the first stage, this difference increases much more rapidly than the preceding figures might indicate, and five highly efficient circuits,—four r.f. stages properly built, will give everything that is desired in the way of selectivity and amplification.

The effect of varying the primary coupling is principally to vary the power of the r.f. amplifier. True, the primary induces certain losses into the tuned circuit, but these are so small, as compared with the others unavoidably present, that their effect is negligible. While changing the primaries varies the amplification, it does not change the ratio of local signal to DX signal, merely amplifying both in proportion and thus selectivity is not materially affected.

The distance of the local station from the receiver also has no bearing on the selectivity, although it has a distinct bearing on what can be heard when the station is detuned by 10 kilocycles. The amount of power received from a local station varies inversely as the square of the distance between the receiver and the broadcaster. Any change in the distance of the local can be completely compensated for at the receiving end by a corresponding antenna change, so that the amount of power received from a local can be kept constant. Assuming a constant power input from the local, the receiver will detune it at 10 kilocycles, no matter how close the station may be. This, of course, assumes absolutely complete shielding of the receiver, and no energy pick-up from the battery leads,—conditions, which are seldom met in practice but which can be taken care of in a properly designed receiver. However, cutting down the antenna to compensate for the nearness of a local will, of course, cut down all other signals in proportion, so whether a DX station on an adjacent wave channel can be heard after such alterations have been made will depend on how strong the DX station happens to be coming through at the time.

"Tuning out" is, after all, a matter of relativity, no station ever being completely eliminated,—merely decreased in proportion to the one that is "tuned in." This can easily be proved on any receiver by adding three or four audio stages to the detector tube. When enough amplification is added in this way, locals that were completely out on the regular set will reappear dimly in the background. To eliminate them, another tuned circuit must be added ahead of the detector tube, and then they can again be made to reappear by still further increase of power in the audio end.

Feedbacks and common couplings are by no means confined to the plate and grid circuits. The worst coupling and the hardest to eliminate is that in the filament circuit.

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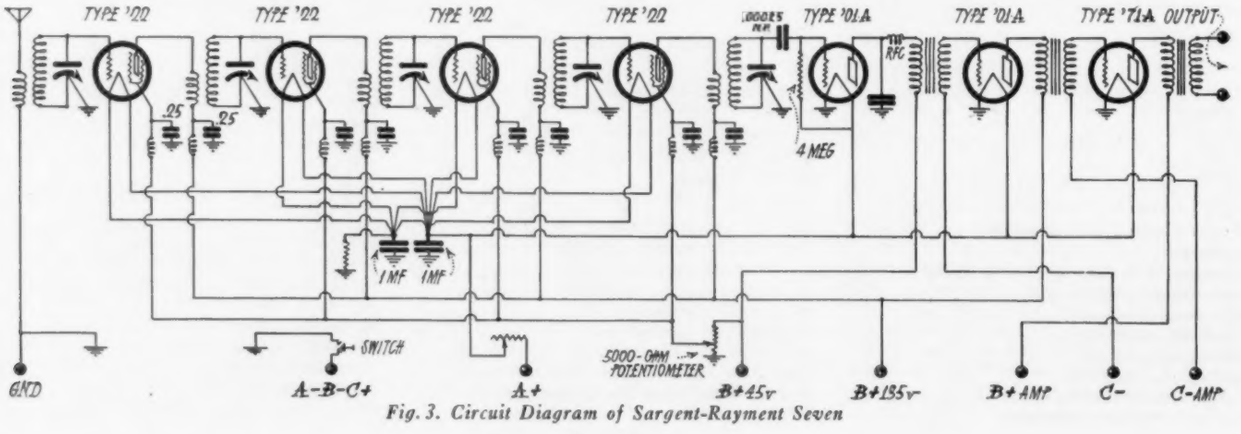


Fig. 3. Circuit Diagram of Sargent-Rayment Seven

The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea *and* Ashore

Edited by P. S. LUCAS
R. O. KOCH, *Assistant*

A LETTER TO THE EDITOR

Sir: Like you, now that I have my ticket, I am looking over my shoulder and casting uneasy glances at the men coming after me. And I find ample cause for worry. The standard of efficiency is descending with alarming rapidity. Yes, it is certainly true, an inferior brand of operators are being turned out with first-class tickets, even though each year brings additional subjects to the examination requirements. And how sadly lacking these new men are in the ability to copy code, even though they must suffer a five hundred letter ordeal on a stuttering omnigraph sending not "twenty words per minute" but "not less than twenty words per minute" as compared to the fast and automatically perfect copying of those revered "old-timers" who had but to place their hands on a Bible, or a dictionary if no Bible was available, and swear a solemn oath that they had committed to memory the characters in the code.

As I sit in my shack, listening to the hubbub of voices on the air, how uncomfortably noticeable is the speedy and quick-thinking traffic work of our English and Swedish and Dutch brothers as compared to the American operators' work which you and I so sadly deplore.

But let me abandon this unseemly levity.

It is, of course, true that American operators receive very imperfect and incomplete training in the various radio schools throughout the country. The only objective of these schools is to get the man his license. No attempt is made to teach him the trade. In most schools very little practical work is attempted and nothing but ancient and obsolete apparatus is used. A newly licensed man gets a job through a connection of his school with a radio telegraph company that he would never obtain if dependent on his own capability.

It isn't that the government examination is too simple. If any thick-witted, absolutely incompetent fellow gets a license it is nothing but the sheerest kind of luck. The examination requires much that is useful and necessary, but it also abounds in queries pertaining to useless and superfluous knowledge.

The only way to change methods of teaching in radio schools is to change the form of examination. Let a man be examined in the practical care and operation of, say, a 2-k.w. navy spark set and a vacuum tube transmitter, with these installations actually on the premises. Have him actually operate a standard ship receiver. Make him show comprehensive knowledge of traffic handling. Do these things and the schools will unhesitatingly renovate their methods of instructions.

But returning more to the spirit of my introduction—please, Mr. Lucas, when discoursing on the defects of American operators, never, never compare them unfavorably with foreign operators. How painfully evident is the "slow, deliberate" training of our foreign brothers whenever they are heard. Few of them are capable of receiving more than twenty words a minute and their "slow, deliberate" sending has brought down upon them more than one bloody curse.

You say these fellows are perfectly at home with their switches. Well, it may be a peculiarity of their types of apparatus, but I doubt that you will find one British, or one Swedish, or one Dutch, or one of any other nationality among fifty of his kind who has a decent spark note and can work one-half the distance a Yankee operator will clear.

The reason for this? Perhaps the United States government examination, although lacking in practical application, is sufficiently severe to exclude from the ranks all who are ill fit for the job. It is certainly true that, although almost invariably a new American operator is a "ham" in the most unfavorable sense of the word, he seldom stays in that category more than a month or two. And the average American operator is so superior to the average foreign operator that there can be no comparison.

Go after those changes in the government examination. You will have the support of every active commercial operator. Such a change will work a hardship on the men now preparing for the examination but in the end it will benefit them and unquestionably raise the standard of the profession.

But sometime I wish you would let me raise my voice against those grisly "old-timers" who gain recourse to your pages to bemoan the sorry condition into which the game has fallen. I smack my lips in anticipation of the beautiful drubbing I would give those birds who worked for forty dollars a month and the captain's old clothes.

With 73's,

RICHARD J. GOLDEN.

S. S. Winifred O'Donnell,
Wilmington, Calif.

OUCH!

We thought this was a bouquet until we got into the middle of it. (It is a brick.) But we made the mistake of asking for opinions so here we are. Friend Golden has a couple of discrepancies like those for which we are now making apology.

In the first place, each year does not bring additional subjects to the examination requirements. The government probably got wholesale rates when it had the present sets of questions mimeographed many years ago, for the supply seems to be inexhaustible.

The comparison of the present system of copying a "stuttering omnigraph" at "not less than twenty words per minute" to the old method of taking one's oath to the effect that he had "memorized the characters" is good. We hate to attack that, but duty calls. It is our humble opinion that this is not a comparison; for everything about the game has developed from the old plaything that it was, to a public and private service calling for ultra-efficiency. The "revered old-timers" to whom Mr. Golden refers, and, by the way, to whom we did *not* refer, were efficient as far as the efficiency of the day went. There were "lids" among them, no doubt. (We're just guessing, having spent those days in three-cornered pants.) And those who were efficient probably "razzed" the lids, "even as you and I."

Let's interpret this "lid" word. With Webster out of it, we'll take a chance at this definition: "Lid" is the term applied to a man who goes to sea without sufficient preparation and is indisposed to improve his operating ability after he once obtains a license and a job. That gives every op plenty of leeway; even the one who has been rushed through an incompetent school and put on a job without ever having seen a spark gap. If he has the desire to attain proficiency he is not a lid, and will not even be called such after a trip or two.

So efficiency in the radio game has developed—and the three important elements in its growth; namely, usage, apparatus and personnel, have grown hand in hand. Each year we find a more efficient operating force—and each year we find a greater need for even *greater* efficiency. Therefore we cannot compare operating ability of today with that of two or twenty years ago.

In OM Goldman's fifth paragraph he says the same thing we tried to express, only he makes it more direct; more effective. Stiffer exams will necessitate stiffer school work. Result: a force of men trained to do their stuff whether they are disposed to continue their training after they get their licenses or not.

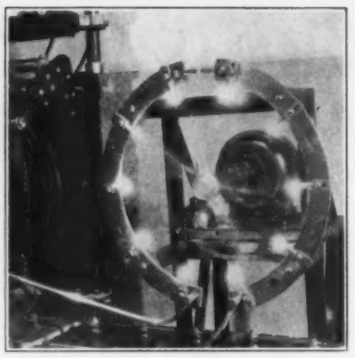
Now to meet the issue; (after stalling as long as was decently possible). We have been accused of comparing the American brasspounders unfavorably with our foreign brothers. We didn't. We compared the systems of education. And, although it seems conceited to say it, we feel that if the average foreign operator had the American training he'd have to get help from a mess punk when he got on shipboard. And of the American op were trained as they train 'em in England, for example, he'd be a real operator from the start. The difference in make-up is nothing to get big-headed about, however. The American is quick to grasp; quick to act; impetuous. The Englishman is slow to learn, and think and act; but when he does learn he retains his learning. When he acts he does so with no trace of indecision. The American jumps from one ship to another; the Limie holds onto his ship as if he owned it.

To sum up this discourse, we believe that if the American operators were *thoroughly*

trained they would create a respect for their profession that would eventually lead to a proportionate advance in salary as well as better working conditions. We still believe, and Mr. Golden believes with us, that the only way to improve the system of training is to advocate stiffer, much stiffer, exams. Please accept our apologies for giving the impression that we considered foreign ops superior to ourselves. 'Twas not so meant.

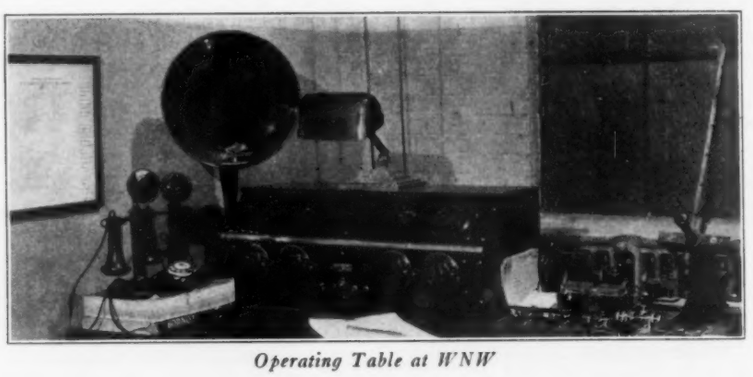
P. S.—Sure, OM, come along with your "old-timer" drubbing. Make it hot and snappy. But we'll bet you a dollar to a doughnut that in twenty years you'll be lamenting the passing of the good old arc and tube days. It is almost inevitable that we should look back upon the days that have gone with a feeling of wistfulness. The hardships are forgotten; the pleasures recalled more vividly each year. But don't let this destroy your anticipation. Shoot the story along for a couple of laughs.

Mr. Ulrich, in his letter, asked whether or not we accepted articles from the operators in Uncle Sam's service. Well, I'll say we do! We used to yell for them quite regularly, until, after six or eight months of no response, we decided to give it up. We are tickled pink to know that some of the Navy gang are interested in the Commercial Brasspounder; and we hope that this first article will inspire some of the rest to write us some dope on what is going on in the Navy.



Spark Dischargers, Condensers and Tuning Inductances at WNW

tion of rather unusual construction. Especially interesting is the good old Marconi spark discharger and the United Wireless "coffin" transformer, which is of 1 k.w. rating. The tuning inductances, load coils, mica condensers, etc., etc., are of recent Navy design, parts taken from a standard 2-k.w. ship set, I should imagine. The input frequency to the transformer is from the regular 60-cycle mains at 110 volts. The secondary produces a pressure of 25,000 volts which is characteristic of the old-time spark sets. The Marconi discharger produces an almost synchronous note which is exceedingly pleasant



Operating Table at WNW

IMPRESSIONS OF WNW, PHILADELPHIA

By Ed G. Raser

Not since the early days of ole "Bs" atop the Bellevue Stratford had Philadelphia been graced with a commercial ship-to-shore station until WNW came into existence two years ago. It materialized the dream of two old-time operators who realized the need for a station to handle traffic for ships plying the Delaware River and sailing along the Jersey coast. NAI at the League Island Navy Yard could not take care of the regular Navy traffic and also keep continuous watch on 600 meters.

The station is located atop the Tidewater Steamship Terminal, one of the largest steel piers in the world. The antenna is supported between two steel masts 60 ft. high. The operating room is one story below, and to me, as I entered, had a very cozy and inviting appearance.

The transmitter is a Composite-Navy affair with apparatus chosen from about every wireless system in vogue during the past ten years. However this does not mean that WNW is not efficient nor shipshape. Every bit of apparatus is placed to advantage from an operating standpoint, and well installed.

WNW is a modernized damped wave station to copy and leaves a never-to-be-forgotten memory of the bygone days.

The receiver is a composite one, being built and designed by Mr. Barrington, one of the owners of the station. All reception is done at loud speaker volume and off shore, traffic pounds in so well at WNW that "break in" can be used on practically all contacts made. A standard Leach Relay is used. Keying may be done from either of the two operating tables.

WNW makes and answers calls on the 600-meter wavelength, then after establishing communication shifts to its regular working wave of 930 meters. This latter channel is also used for marine intelligence, storm warnings, etc.

The antenna is a four-wire flat top affair, approximately 250 ft. long. Due to the extremely high potentials developed it is insulated throughout with solid glass rod insulators, some 5 ft. in length.

A careful log of all ship positions are kept in much the same manner that a train dispatcher keeps his record of trains along the right of way. This is especially valuable to the many clients of WNW, as many phone calls are received, requesting positions of various ships and their probable time of arrival. This is a service which has gone a long way toward making it one of the most popular coast stations on the east coast. J. Donald Haig, the station's chief operator, is an old-time commercial man.

AN ULTRA MODERN MARINE RADIO INSTALLATION

By Viggo C. Eberlin
Chief Operator, S. S. Esparta

The Et 3627 R. C. A. telegraph transmitter, with its rated output of 200 watts, wavelength 600-900 meters, employs the master oscillator, power amplifier type of circuit. Tuning consists fundamentally of setting the master oscillator at the desired wavelength, which is determined by the use of a wavemeter, and then resonating the antenna circuit for maximum current. The master oscillator variometer, which is mounted in the lower left section of the panel, is provided with a five-point positioning device so that it may be calibrated for any five wavelengths within the band and the movable stops then locked at the correct places. At the same time, however, intermediate wavelengths from the five normal ones may be obtained easily by setting the pointer at the proper position.

The antenna circuit is tuned by means of a four-point antenna inductance switch and the antenna variometer. The variometer is designed with sufficient range to overlap the taps on the coil so that a continuous inductance range may be obtained.

The only adjustment to be made inside the transmitter is that on the antenna transformer plate winding. This winding has several taps brought out to a terminal board and is used to permit adjustment for maximum efficiency on the particular antenna with which the transmitter is to be used.

Unlike the more up to date type of 750 watt transmitters manufactured by the R. C. A., the chopper method of I. C. W. transmission is brought into play. When the signal switch is placed in the I. C. W. position, one pair of contacts on this switch start the chopper motor and the other pair remove the short circuit maintained around the chopper during C. W. transmission. The grid leak circuits of the master oscillator and the power amplifier tubes are broken by the chopper at the rate of approximately 1000 times a second in order to produce I. C. W. telegraphy. The chopper wheel, therefore, breaks grid current and the brushes and the surface of the wheel should be maintained in good condition.

The brush which bears on the chopper wheel proper is made of spring silver in order to secure good contact to the segments. It is held against the wheel by a small spring. Only sufficient pressure should be exerted by this spring to make good contact, as excessive pressure will cause an undue wearing away of the silver brush. The tension of the spring is governed by means of a screw affair which, when once properly set, can be locked into position by means of two small lock nuts. The best criterion of a suitable adjustment is to listen to the I. C. W. Note in the receiver, using only sufficient pressure to secure a clear note. Little attention need be given the copper mesh brush making contact with the collector wheel. The chopper wheel as previously stated should be kept clean at all times, it will be noted after considerable usage that a blackened surface will result. This should be cleaned by means of very fine sandpaper (00) if obtainable and used with a hard wooden block so as to insure a flat surface and no rounding and ridging of the segments of the chopper wheel.

The transmitter should be kept clean at all times in order to secure proper efficiency. A good stunt is to obtain a new paint brush (1½ in. round type is best) and keep this for the sole purpose of cleaning the inner parts of the transmitter.

Some installations make it necessary that the transmitter be set close to a port hole and is more than likely to collect salt spray at

some time or other. If this be the case it is advisable to secure a canvas covering which if measured and properly made will fit over the sides and back of the frame of the transmitter and can easily be secured there. This will prevent any salt or dampness from accumulating on the various parts and will save the operator from trouble which would surely result at some time from the damaging effects of the salt or dampness. The covering also will keep out much of the dust which normally accumulates in the course of time. Do not cover the top of the transmitter, as it will be necessary from time to time to get at the tubes or chopper wheel.

Very often when in the vicinity of the tropics or during severe damp weather there will be a tendency for the radiation to drop considerably. This is usually caused by the high frequency leakage over damp portions of the transmitter. The only way to overcome this is by installing a pilot lamp which should be set as low as possible inside the transmitter, away from anything which may be damaged by too much heat. The higher the wattage the more heat the lamp will radiate. This tends to keep the apparatus free of moisture at all times. A small heating unit would also serve the same purpose.

All tubing connections inside the transmitter are treated with lacquer and no attempts should be made to clean with brass polish. If the operator so desires he may wipe them off occasionally with an oil dampened cloth.

By inserting in series with the chopper motor the proper size resistance, the motor can be made to run a little slower than normally. This will give slightly increased radiation and a better note. It also tends to give the I. C. W. a broader effect and enables the operator to raise a ship with greater ease and much less calling, thereby only causing the minimum of interference which is an extremely important point in the radio game. (One combination which works very well is a fifty-watt lamp in series with a regular fan motor variable resistance. The operator then can change his note from time to time to suit conditions.)

The key relay which is mounted on the front part of the panel should be given the usual attention as to clean and even contacts. Care should be taken when installing the receiver antenna connection not to run the antenna receiver lead in from the rear of the transmitter panel too close to any high-frequency line. This results in much unnecessary induction in the receiver itself.

The motor generator supplied with the set should be given the usual attention which is given other motor generators. Keeping the high voltage commutator well cleaned and also the a.c. slip rings which supply filament current to the transmitter tubes.

Do not fool with the meters on the transmitter panel unless you are well experienced in that line.

Occasionally an operator will blow a plate fuse or puncture a by-pass condenser. This is usually due to negligence on the operator's part. By watching the meters and keeping the voltages at their proper working values one will not be bothered by blown condensers or fuses. The best value for normal working is 10 volts for filaments of tubes and 900 to 1000 volts for plate voltages.

If your receiver should go dead at any time be sure and look at the antenna fuse (½ ampere) located on the rear of the transmitter panel. Very often this fuse goes out, and if not known by operator, will cause any amount of trouble in locating the difficulty.

Your automatic starter should be adjusted to bring the motor generator to a full speed in 4 to 5 seconds.

And don't forget to use C. W. and QSY whenever possible so that the other fellow will have a chance.

'ELP!

An epidemic of Spring Fever seems to be going its rounds. We need stories, or dope to write stories about. Quick!

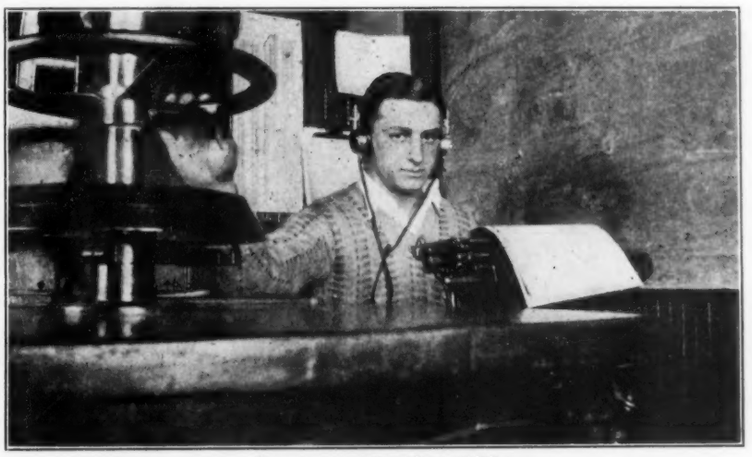
Long time since we've had a constructional article. Nobody building anything?

Or how about your ship, or some land station on your run?

FROM A NAVAL RADIO COMPASS STATION ON A LONELY LITTLE ISLE

By F. L. Ulrich

For the last six years I have been pounding brass for Uncle Sam aboard ship and ashore, and have had the pleasure of working many commercial ships and stations. That every commercial op knows the value of the radio compass stations which Uncle Sam maintains is shown by the fact that we never handle less than one thousand bearings a month at NBS. I believe it is unnecessary to describe the radio compass, as every op has a fair understanding of its operation and uses. In the following paragraphs I want to give a few pointers and mention several instances where the Naval radio compass has rendered valuable assistance to vessels at sea.



Operator on Watch at NBS

The Navy Department maintains over fifty radio-compass stations, which are located on both coasts, Gulf of Mexico, Great Lakes and the Canal Zone; and recently one has been put into operation at Hilo, Hawaii.

To operate a radio compass efficiently the operator is required to have a good sense of hearing to distinguish signal strength, and a pair of good eyes to observe the minimum, both of which must work together while taking a radio bearing.

Radio bearings when furnished to vessels within one hundred miles of a radio compass station can actually be relied upon. When two or more radio compass stations concentrate on a vessel at the same time, the vessel's position can be plotted as indicated by the point of intersection of the different bearings. It is a well known fact that if three compass stations' bearings intersect at one point the vessel's position is entirely correct, but at times they form a small triangle, within which lies the ship's position. If the navigator doesn't want to place too much confidence in this triangle, he can again request bearings from the same stations some fifteen or thirty minutes later, which may result in a perfect cross.

When "night effect" is present between sunset and sunrise, observations sometimes show that when a vessel is testing for a radio bearing the minimum covers a larger number of degrees than usual. Sometimes, in spite of retuning with the compensating condenser, there is hardly a variation in signal strength over the entire 360 degree azimuth of the loop. For this, there is at present no remedy. When it is present and a minimum within four or five degrees is available, a doubtful bearing may be forwarded to the vessel, along with a SVC notifying him of the situation.

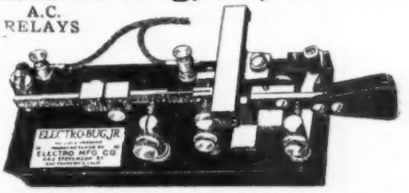
When the *Malolo*, KII, was making its shakedown cruise last summer, it collided with another vessel four miles east of the Nantucket light-ship. By the aid of our compass the *Malolo* was able to plot her exact position so that she could give it to nearby vessels who were rushing to her assistance and the day was saved. (It was foggy, otherwise the light-ship could have been sighted at the short distance of four miles and the collision avoided. As it was, radio bearings alone were able to lend a hand.) The *Malolo* now proudly runs between the West Coast and Hawaii, covering a distance of over 2000 miles in less than four days, instead of resting peacefully in Davy Jones' Locker.

I recall another instance when I was doing compass work at NPW, Eureka, Calif. The *Daniel Kern*, KDXG, somehow or another developed a leak below the water line and her pumps were unable to handle the large amount of water rushing into her hold. Her distress signals were picked up and radio-compass bearings were obtained on her auxiliary transmitter. The Coast Guard cutter *Cahokia*, NITV, was ordered to rush to her assistance at once. The *Cahokia* was in-

(Continued on Page 46)

Electro-Bug, Jr., $12.50

A.C. RELAYS



A full size, highest class instrument. Special introductory terms—half with order, half in 30 days. Five-day trial, money refunded if not satisfactory. SPECIAL WIRELESS MODEL $17.00. ⅜" silver contacts, extra heavy cord, will work any hook up. Same terms and guarantee of satisfaction as Junior.

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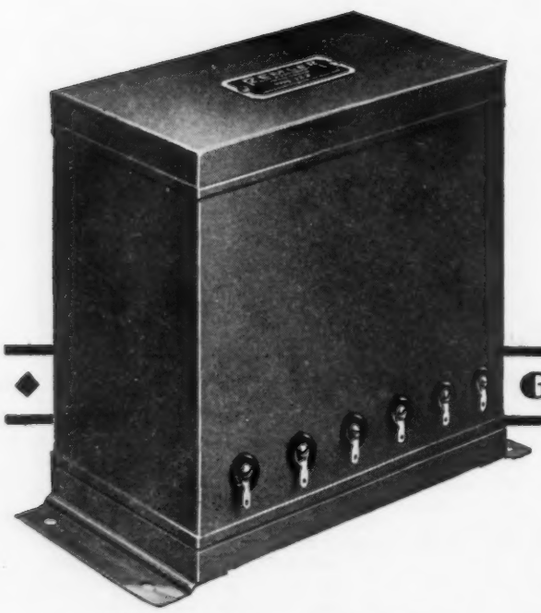
443 Stevenson St. San Francisco, Calif.

Remler's TRIU

This *New* Audio System gives *Set Builders a Tremendous Advantage!*

GUARANTEED BY OVER 10



Make your own test for tone perfection

Almost any audio-system will reproduce bass notes if the volume control is turned way up. But the real test is the reception you get when volume is reduced to almost a whisper. If the bass tones are lost, then you know that your audio-system is not what it should be. Test your own set this way. Then compare it to a receiver operating with Remler Audio-Transformers. The marked difference will convince you that the term, "Tone-Triumph," is no exaggeration.

You know that tone clarity is made—or marred—in the audio end of your receiver. You know that your audio-transformers play a vital part in delivering undistorted audio-frequencies to your speaker.

Now Remler raises tone standards to a new pinnacle of technical accomplishment. Only with the Remler Audio-Transformers can you get the tone range and undistorted reproduction which will put your reception in a class by itself. Now you can meet your audio-transformer needs from a full Remler line.

The Remler Laboratories have solved the problem of perfected reception in a unique way. There is no substitute for the results you secure when you put Remler Audio-Transformers to work in your circuit.

The practical and proven idea of Resonated Windings—applied in a new and simple way—is the basic principle behind the Remler System of Audio-Transformers. Used with Dynamic Speakers, installed according to our instructions, the Remler Transformer Team, Nos. 920, 921, 923, gives a high-gain and undistorted power output absolutely unequalled in any other system.

New Tone M P H

No. 920, with resonated primary, gives a slightly rising frequency characteristic at the lower end of the scale, which compensates for the falling characteristic of No. 921, and produces a straight line amplification curve. No. 923 is intended to follow the CX350 or UX250 Power Tube. The Secondary is tapped for either magnetic or dynamic speaker. Isolation of Power Tube plate current eliminates direct-current saturation.

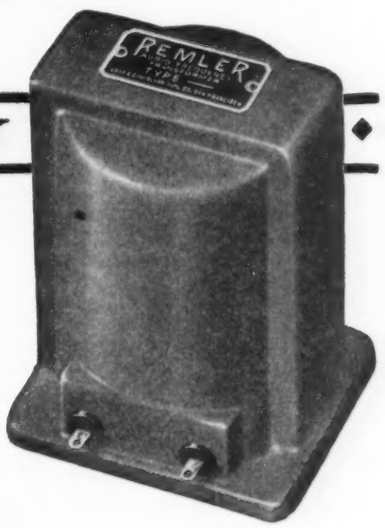
Another reason why your radio should be custom built

Only in a custom-built receiver can you get the new Remler Audio System. The Professional Set-Builder keeps his product up-to-date from month to month. He has a tremendous advantage over the manufacturer who must plan a full year ahead.

Progressive set-builders are already placing advance orders for these new transformers. They will place them in the new receivers they build this fall. They will reconstruct many sets built last year in order to bring them up to 1928 audio standards.

REMLER adds six new audio-transformers

No. 920. Resonated Primary, first stage, 4½ to 1 ratio	$12.00
No. 921. Second Stage, 6½ to 1 ratio	$12.00
No. 923. Output impedance compensating Transformer	$20.00
No. 900. Resonated Primary first stage, 3½ to 1 ratio	$8.00
No. 901. Second Stage, 3½ to 1 ratio	$8.00
No. 922. Output Transformer	$10.00



YEARS OF REMLER RELIABILITY

Remler is proud of this latest addition to a line that for ten years has stood for absolute radio reliability. If you really enjoy tone-perfection, if you demand true tone-clarity, sign and mail the coupon below. We will send you complete information about the Remler Audio System, what it is and what it does.

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Send me your Bulletin No. 15 giving all the dope on the new Remler Audio-Transformer System.

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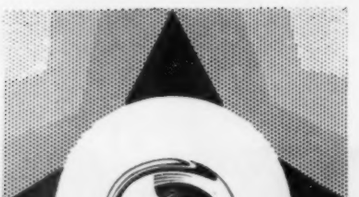

Increase
your radio
enjoyment

BY replacing each tube in your set with a *new* Cunningham Radio Tube you are sure of clear, resonant tone. You are virtually giving new life and energy to your radio, and you thereby increase your radio enjoyment.

Don't use old or inferior tubes with new ones—use new tubes throughout.

Look for the name
CUNNINGHAM
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E. T. CUNNINGHAM, Inc.
New York Chicago San Francisco

Cunningham
RADIO TUBES

RADIO GROUNDS

(Continued from Page 30)

"If two pipes are driven side by side, almost in contact or a few inches apart, the resistance of either to a distant earth connection is the same as when both are connected in parallel. For instance, if the resistance of one pipe to a distant earth contact is 15 ohms, the resistance of the two in parallel to the same distant point will be approximately 15 ohms. This is due to the fact that one pipe is driven into the dense current field of the other, and consequently can add nothing to the distribution of the current over a large cross-sectional area of the earth. In order to decrease the resistance of pipe earth connections in multiple, it is necessary to space the pipes 6 feet or more apart. With this distance apart, and spaced not more than 10 feet apart, the total resistance of a number of pipes in multiple to a distant earth contact will decrease almost in proportion to the number of pipes."

"In general, it can be stated that most of the resistance between two pipe earth connections resided in the immediate vicinity of the pipes. Since driving two pipes close together and connecting them in parallel does not materially decrease the resistance, it is evident that increasing the diameter of one pipe will cause very little decrease in resistance. A pipe just large enough for mechanical strength in driving is all that is required. Since the resistance resides mostly close to the pipe, and conductivity of soil is due almost entirely to moisture, the conductance may be greatly increased by adding a good electrolyte, like salt, to the soil close to the pipe. Salt not only increases the conductivity, but being hydroscopic maintains it by attracting and holding the moisture upon which the conductivity so largely depends. Even if the pipe does not quite penetrate to the natural moisture level or strata of the earth, the salt will do so, as a rule, and thus establish a good connection."

There are several substances which have the same effect as common salt in increasing the conductivity of the earth. Not all of them are hydroscopic, but all of them are either more expensive or less common and more difficult to obtain every place without being any more effective than common salt. Copper sulphate is rather cheap, but not any better for the purpose than salt, and is objectionable because even a small percentage of copper sulphate in the earth will corrode most metals available for earth contacts and will kill vegetation, grass, flowers, etc., very quickly.

Galvanized iron pipe grounds which have been well salted have been examined (Wolf, G. E. Rev., Vol. 18) and show no depreciation after several years in the earth. Fig. 2 shows the effect of salt and water in lowering the resistance of grounds made with ¾-inch iron pipe driven 5 feet into the earth.

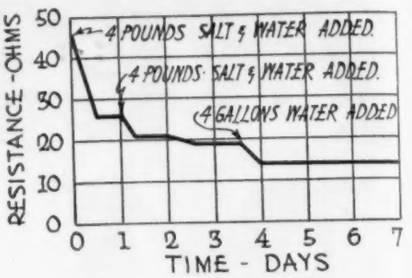

Fig. 2. Effect of Added Salt and Water on Resistance

SUMMARY:

1. Gas and heating-system pipes should never be used for a receiving set ground connection.

2. Water-pipe systems may or may not offer a good ground connection. Where pipe systems are insulated between the meter and earth, they are no better than heating pipes. Where compounds such as "leadite" or cement are used in pipe joints the receiving set will not give its full volume, will be broader in tuning and less able to receive distant signals when the set is grounded to such pipe systems.

3. Electrical disturbances from power lines are apt to be increased where sets are grounded to pipe systems.

4. A good independent ground will, in general, give better all-round results for broadcast receiving sets.

5. A satisfactory independent ground contact is made by driving a ½ or ¾ in. galvanized iron pipe, not less than 6 ft. nor more than 8 ft., into the earth and then providing means to maintain moisture around the pipe and to periodically impregnate the surrounding soil with common salt.

6. Where an unusually low-resistance earth-contact is desired, or where the soil is dry, sandy and gravel, two or more pipes may be driven not less than 6 ft. apart, nor more than 10 ft. apart, and the two or more pipes connected in multiple to form the ground for a receiving set.

RADIO NOTEBOOK

(Continued from Page 32)

other end of the telephone line exactly as though a human being were speaking the words into the transmitter. This is the same principle as employed in the "Movietone" system of talking motion pictures, and indicates that the commercial use of the photo-electric cell is destined to make it a rival of the vacuum tube.

Tell them you saw it in RADIO

SHORT WAVE ADAPTER

(Continued from Page 26)

not to disturb the *B* supply voltages to the detector and audio stages. It will take nearly a minute in most a.c. receivers for the cathode to heat up sufficiently so that signals can be received, and if it takes much longer for this to occur than is customary when the set is used on broadcast waves, then the resistance of the flexible wires between the adapter and the receiver, in the heater circuit, is too great.

The antenna lead-in should be connected to a single pole double throw switch, so that the antenna can be quickly changed from the broadcast receiver to the short wave set. Tuning is exactly the same as for d.c. short wave sets. The tickler condenser is tuned until the detector oscillates, which can usually be determined by moving the condenser quite rapidly back and forth until a hissing sound is heard, and then backing off the condenser until the noise disappears.

In the case of an a.c. adapter, when the tube oscillates, a slight increase in a.c. hum will be noted, so that it is quite easy to find the point where regeneration is at a maximum, which is just before the oscillation commences. If the tube breaks into oscillation with a loud pop, the grid leak is of the wrong size; one of around 5 megohms will be found about right for the average '27 a.c. tube. It is important to use a high ratio vernier dial for each tuning control, as tuning at waves as low as 30 meters is quite critical, and requires a little practice in order to obtain the best results.

To facilitate the location of the short wave broadcasting stations, the following table has been arranged, and while no guarantee of accuracy of wave or time of operation is implied, it is correct as near as we can determine at the time of writing. The time is expressed as Eastern Standard; Central time will be one hour earlier; Mountain will be two hours earlier; and Pacific time is three hours earlier.

U. S. SHORT WAVE STATIONS

Call Letters	Location	Wave-length	Time of Operation p. m.
WJZ-3XL	New York, N. Y.	59.96	7 to 11
WGY-2XAF-2XAD	Schenectady, N. Y.	21.96 33.10	8 to 11
WRNY	New York, N. Y.	30.91	7 to 12
WOR	Kearny, N. J.	65.40	7 to 11
WLW	Cincinnati, O.	52.00	8 to 12
WOWO	Ft. Wayne, Ind.	22.80	8 to 10
WCGU	Brooklyn, N. Y.	54.00	7 to 11
KDKA	Pittsburgh, Pa.	27.00 62.50	8 to 11

FOREIGN SHORT WAVE STATIONS

Call Letters	Location	Wave-length	Time of Operation
2ME	Sydney, Aust.	28.5	Indefinite
3LO	Melbourne, Aust.	36.0	1.30 p. m.
5SW	London, Eng.	24.0	7.30 to 8.30 a. m. 3 to 6 p. m.
2NM	England	33.0	Indefinite
RFN	Russia	50.0	6 to 10 a. m.
PCJJ	Holland	30.2	1.30 to 4 p. m.

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Radio set builders and manufacturers who realize that a radio must be judged by its performance, specify Polymet Products whenever it is a question of condensers, resistances, grid leaks, rheostats, plugs or potentiometers. Send for the Polymet catalog showing new products.

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(Ideal for Use With Dynamic Speaker)

Model AP-935

As the Uni-Rectron stands it is a super power amplifier, which can be used in connection with any radio set and loud speaker. Binding posts are provided for input to the Uni-Rectron and output to the speaker. Requires no batteries for its operation. It obtains its power from the 110 volt, 60 cycle alternating current lighting circuit of your house.

List Price $88.50 Each
(without tubes)

Special at $19.75 Each
Every one new and packed in original factory carton

The UX-210 super power amplifying tube and the UX-216B or 281 rectifying tube are used with this amplifier, which cannot overload. From the faintest whisper to the loudest crash of sound—R. C. A. Uni-Rectron amplifies each note at its true value. High and low notes are all treated alike. The volume and quality delivered will be a revelation.

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The CeCo line of A.C. tubes is most complete, embracing practically every existing type

CeCo Tubes are carried in stock by dealers everywhere. Write us for unusual and interesting booklet entitled "Getting the most out of your Radio."

CeCo MANUFACTURING Co. Inc.
PROVIDENCE, R. I.

PHONE TRANSMITTER

(Continued from Page 35)

place of the one already in. Now adjust neutralizing condenser and its tap until the current in the amplifier circuit reads somewhat less. Then readjust the wave and reneutralize until the current in the closed circuit of the amplifier is down to nearly zero. When this condition exists, the circuit is perfectly neutralized but the writer has found that it could not be realized in practice due to some unbalances that could not be avoided. It must be kept in mind that this neutralizing procedure is all done when the plate voltage is disconnected from the amplifier. The plate voltage can now be safely applied to the amplifier with no danger of injuring the tubes provided that there is little or no magnetic coupling between the oscillator and its amplifier. The amplifier should now read 60 mills per tube. The antenna can be coupled in any of the conventional ways. The important thing to remember in a power-amplifier is to get as high a tank current as possible with a low value of plate current, and then operate just a little above this point. It would be advisable to check the antenna current to see whether it rises in proportion with the plate voltage, a point which cannot be over-emphasized because you must have a straight curve for perfect modulation, due to the tremendous instantaneous voltages that are set up in the antenna when modulating.

The microphone should be a two-button type stretched diaphram if possible, but since it is very expensive a single button telephone variety will do, and the latter is shown in the circuit diagram. It will be noticed that the secondary of the microphone transformer is shunted with a 500,000 ohm potentiometer which is used as a volume control and to prevent the first tube from overloading. The successive tubes are able to withstand the voltage output of the first tube so that the whole circuit is operating below the overload point. The first tube, by virtue of the input resistance R_5 can be controlled so that it will not distort, and the second tube is biased with 12 volts negative, insuring a large grid swing. The plate chokes in the first two stages are high enough in inductance to provide straight line amplification through the audio-frequency range. These chokes are all designed so that with not over 10 m.a. of d.c. flowing through their windings, there is little effect on their inductance curves as far as audio-frequencies are concerned.

Now we see that we have a practically distortionless amplifier up to the modulators. The output of the second stage is fed through condenser C_{12} to a grid-leak of approximately 10,000 ohms to the modulators. The modulators are biased with about 50 volts so as to draw about 25 mills each. This is the best part of the curve for our purpose. When actually modulating we note very little change in plate current of the modulators, and we can get nearly 100 per cent modulation without letting the grids of the modulators go over one or two mills positive. Our whole audio-frequency circuit is working below the point of distortion making for good quality and due to the fact that we have three modulators connected in parallel the Heising choke need not be over 30 henries. Care should be taken, however, that the chokes selected are able to carry the combined current of the amplifier and the modulators or a total of nearly 200 mills without saturation. It may be necessary to parallel two 100-henry chokes such as are used in eliminators. Saturation will result in distortion which is not so noticeable on voice as on music.

The best way to tell whether the set is completely modulated is to keep on increasing the audio-frequency input until the antenna ammeter deflects up. A good rule to follow is to not let the grid current of the modulators rise above one or two mills. Keep all leads short so as to avoid radio frequency feedback into the audio system, characterized by a squeal and an enormous increase in grid current on the modulators. If the microphone lead is long it should be shielded with lead.

This transmitter has been tested under the most severe conditions and its range is remarkable. Modulation tests showed that all frequencies from 100 cycles to 5000 cycles were being transmitted and the S's in the speech were present. Remember to keep the audio-frequency at a constant level; that is, let the modulator grid current rise to one or two mills when using voice, and a transmission that will be a delight to listen to will be the result. Observe the values shown in the drawing, and the type of tubes used. This transmitter can easily be converted to 50 watts or 100, substituting 50-watt tubes in place of the 210s, as the oscillator will furnish grid swing to operate a 50-watt tube.

SHORT WAVE STUFF

(Continued from Page 34)

discharge out of phase, causing slight flashing at the key or relay points.

Comments on the "different" tone can be blamed onto the mercury arc. The whole thing seems to center around such small details as, for instance, putting a coil of wire around the legs of the arc. Some arcs require tinfoil closely wrapped around each leg for a distance of from one to four inches, this being necessary before the tube will "shoot." However, by replacing the tin foil with a coil of about 500 turns of fine wire of a diameter large enough to pass the maximum plate current the tone and even the sharpness of the wave can be varied. The plate voltage is caused to pass through the length of the coils before entering the rectifying arms. The direction of current flow will affect the arc differently and the leads should be reversed, noting the effect.

The distance the coil extends down the length of the arms will govern to some extent the "starting" voltage and in consequence the character of the output. This with a variable center tap such as a 110-volt heater element with a slider arranged to vary the center tap the arc can be filtered with a single choke and condenser to give nearly pure d.c. having only a slight percentage of modulation.

The arc is started automatically by means of a "buzzer" type shaker. The arc is shaken with a lateral motion, this being much easier on the tube mechanically besides being more effective with less movement of the tube. A no-voltage-release coil is rewound with heavy wire and connected in the center leg of the keep-a-live circuit. The arm of this relay carries two contacts which are held open while current is flowing in the keep-a-live circuit, but in the event of the arc going out the contacts are released and close the shaker circuit and the starting electrode. The inertia of the arc is sufficient to keep the period of vibration low and is adjusted somewhat by a spring which holds the contacts closed.

For some time a shield grid receiver has been in use here, of the usual variety. A new arrangement built around another development of Mr. Lee is an a.c. heater type shield grid tube. This tube by comparison and measurements has proven to be superior to anything yet tried Tests prove it to be fully a hundred per cent better than the standard d.c. filament SG tube. The receiver as used now is completely operated from a.c. and on head phones no trace of hum is noticeable. Heater type tubes are used throughout.

Complete dope will be given on the thing as soon as data can be arranged.

NATIONAL

TUNING UNIT TYPE 222

For Experimental use with the new Screen Grid Tube

A NEW NATIONAL Browning-Drake Transformer, together with a new and beautiful Velvet Vernier Drum dial, Type F, brings out the good qualities of this highly efficient tube in a manner that is both pleasing and inspiring to the experimenter. Perfectly stable operation is obtained without the use of cumbersome shields or other energy-absorbing devices. The rigid workmanlike construction of this unit makes its installation simple and permanent. No cutting of sub-panel is required. Everything goes into place with a minimum of fitting and wiring. You will be agreeably surprised at the efficient results derived with this tuning-unit when used with the UX 222 tubes. *List Price type 222* **$25.00.** Two other types also available.

NATIONAL PUSH-PULL AMPLIFIER-for 210 or 250 tubes.

For the fidelity and volume of distortionless audio reproduction now required by modern radio standards and now made possible by recent speaker developments. The curve is "flat" over practically all audio-frequencies, the power output sufficient for the largest hall. The design is compact—the quality is NATIONAL.

NATIONAL SHORT-WAVE EQUIPMENT for use with 222 tube

This NATIONAL Velvet Vernier Dial Type E and special Equicycle Short-Wave Condenser are now offered by NATIONAL CO. INC., for experimental work in short-wave reception of broadcast, code and television signals. Also offered are newly designed short-wave R. F. Transformers in a set of 4, covering the bands from 15 to 115 meters, R. F. Choke, H. F. Impedance, special Panel and sub-Panel with all sockets and mounting clips.

Send for new Bulletin 130-P

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For Filament Control

Pattern No. 190
A. C. Voltmeter

The advent of vacuum tubes having filaments excited from alternating current has created the necessity for an absolute means of controlling the voltage applied to the filaments. Variation in house lighting voltage is often such that a permanent setting of the filament rheostat cannot be made with any assurance that it will be correct for more than a few minutes. Again the characteristics of the radio set are frequently found to be such that a particular setting of the filament rheostat is necessary to eliminate objectionable hum.

For A. C. filament control the Jewell Pattern No. 190 A. C. panel mounting voltmeter is ideal. It has a body diameter of 2 inches and in general appearance is the same as the Jewell Pattern No. 135. The movement is an accurate, moving vane type, designed for continuous service with special modifications for the small size case. Energy consumption is very small.

The instrument is available in ranges of 0-1.5, 0-3, 0-8, 0-10, 0-15 and 0-150 volts.

Write for descriptive circular No. 1145

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And the dealers will have a pre-view at the

NEW ENGLAND RADIO TRADE SHOW

AUGUST 1 AND 2

Space in the Trade Show is limited to exhibitors in regular October Show and given free to manufacturers in proportion to space held.

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OCTOBER 16, 17, 18, 19

Providence, R. I.

Write or Wire

SHELDON FAIRBANKS EXPOSITION, INC.

209 Massachusetts Ave., Boston, Mass.

COMMERCIAL BRASSPOUNDER

(Continued from Page 39)

formed time and again as to her position obtained by radio-compass bearings, as the damaged ship was drifting constantly to the southeast. Along about evening the *Cahokia* located the *Daniel Kern* and took her safely in tow for Eureka. Again the day was saved.

Last summer (1927) many bearings were obtained on those transoceanic flyers' planes which carried radio, several were also obtained on Commander Byrd's plane, keeping a check on his position, should an accident occur.

Now a word about NBS. This station is on the lonely little isle of Nantucket, thirty miles off the southern coast of Massachusetts. As it is rather difficult for the men to get to the mainland very often, recreation and entertainment are sought on the island. Dances are given every once in a while, and motoring, hunting and swimming are indulged in quite a bit. The population is just a few thousand, consisting mostly of fishermen, coast guardsmen, lighthouse keepers and a few retired business people. Uncle Sam doesn't forget us here, but furnishes us with several daily papers from Boston (a little late, of course), magazines, athletic gear, ammunition, etc. Such is the life of a brasspounder on an island not much larger than a large rock at sea.

The three stations in this vicinity, namely: NBS, NGO and NAE furnish some excellent crosses on vessels when they arrive off the Nantucket Lightship, and they work together speedily and accurately when heavy fog sets in. Each and every one of the stations are furnished with a chart of the vicinity in which it operates, and when plotting bearings, we hit 'em right on the head.

I am sure that if some of the operators that go by NBS, happen to read this article they will vouch for me in making these statements. There are many dark and stormy nights, when the radio compass hears the cries of lost ships, and says: "there you are."

P. S.—I just remembered another thing. Some time ago an English vessel was coming up along the coast and asked "QSJ QTE?" I informed him that this was the good old U.S.A., and that we did not charge for radio bearings. (You know that in England it costs five shillings ($1.24) for a radio bearing.) Well, that Limie kept on requesting so many bearings after that SVC, that I began to think he was Scotch.

GENERAL TRANSATLANTIC NOTES

By FRED V. TRUEBLOOD

Ice Reports

VCE	CAPE RACE, N. F.
GMT	WAVE
0215	600 Spk.
1415	600 Spk.
NAA	ARLINGTON
75th Time	WAVE
1030 AM	2655 ICW
955 PM	2655 ICW
NOON	2655 ICW

Ice Patrol Boat

NIDK—75th. Meridian Time. 6 a.m. and 6 p.m. on 600 Spark. 7 a.m. and 7 p.m. on 1621 CW. Message sent 3 times with 2 mins between times.

UA, Nantes, France, sends very good WX at 1230 GMT on 2800 Spk. He covers general Atlantic weather conditions.

BZB, Bermuda Dockyard, 32. 19 N., 64.50 W. Local weather report. 0015 and 1215-1600 spk. 0020 and 1220 GMT, 600 spk.

PQT TERCEIRA, AZORES. 38.40 N., 27.08 W. 1000 spk. New international code (very good), 0830, 1330, 1830, 0030 GMT.

LETTERS TO THE EDITOR

Anent Hamantics

June 5, 1928.

Sir: I have read with interest the articles "Hamantics" by Paul Otto and "Why Present Radio Conditions," by L. W. Gillis in the June issue of RADIO and I would like to offer a few comments for publication or not as you choose.

I might explain that I am an ex-navy, ex-commercial, ex-broadcast operator and at present operator amateur station 1VB, so that I feel I can see all sides of the operating game, although I admit I have been out of touch with the commercial game for a few years.

Both Mr. Otto and Mr. Gillis seem to use that word "Ham" quite frequently, the former using it, in my opinion, in the correct sense, while the latter specifically designates the amateur. It is regrettable that this word is used, not only by Mr. Gillis, but by many others, including some amateurs themselves, in place of the word "amateur." For there are plenty of "hams" in the commercial game, as Mr. Otto says, more than there should be, considering their duties and responsibilities, especially so when compared with the amateurs where he practically hurts no one but himself.

Mr. Gillis may be right in some instances where the amateurs are "ousting" the commercials but I think he is more or less pessimistic, as the commercial game appeals to only a small minority of the amateurs. Their chief interest is experimenting, "monkeying" with different circuits, etc., while the routine of standing watches in commercial work does not appeal to them. They like to obtain a commercial ticket, hang it up in their own shack, and forget it as far as really using it is concerned.

Mr. Gillis uses one or two hard names in referring to his "Hams" and I am afraid he forgets that there are "saps" and gentlemen in all kinds of businesses and trades. This holds true in the commercial as well as the amateur ranks, and I do believe many a commercial operator leaves a poor impression on a "hard-boiled first mate or shell-backed skipper" perhaps not in the same way, but just as bad.

I presume Mr. Gillis is a commercial operator. What made him a commercial operator? Does he forget his first trip when he was "green"? And possibly "greener" than any amateur that ever went to sea. I do mine and I can't say that I exactly brag about that trip.

Does he forget that the average amateur is as well versed in radio theory and operating as the average commercial as far as actual operating goes? Does he realize that many an amateur can handle a key as well and in plenty of cases better than a commercial? And another question: Who formed the backbone of the navy operators during the war? The amateurs, not the commercials, as the number of commercials in the game then was only a drop in the bucket to what the navy needed. And I think Mr. Gillis can well place part of the blame of the plentifulness of operators to the war when the navy and army rushed thousands of men through radio schools.

No, Mr. Gillis, I think you are making a mistake when you so heartily blame the amateurs as a whole and you will find your "Hams" in the commercial ranks as well as the amateur. The amateur is here to stay, this last international conference at Washington settled that and it seems to me the better plan for an understanding between the two "clans" is a breakdown of the barrier the commercials have intentionally or unintentionally set up. Many a commercial would profit by turning amateur for a while.

Very sincerely yours,

WALTER L. GLOVER, 1VB.

Newtown, Conn.

Regarding Torusolenoid Coils

Sir:

A question has been raised on the method of inserting a primary in a torusolenoid for the purpose of making it a radio frequency transformer following the publication of the original story on pg. 22, May, 1928, RADIO.

If it is remembered that the torusolenoid is essentially two ordinary coils connected in parallel, much of the mystery surrounding the placing of a second winding in their field will be dispelled. Since there are two coils, two primaries are required to give symmetrical coupling of the circuits, one primary associated with each main coil. Each primary is wound in the same direction as the secondary in which it is placed, exactly as would be done were the primary to be wound on the form of an ordinary r.f. transformer.

The primary coil is wound with the wire "bunched" and is slipped in between the turns of the main coil so that they are both coaxial. One primary is placed at what would be the end of each main coil, were they separate. Since corresponding ends of the torusolenoid coils are adjacent to each other, both primaries are located close together.

The inside ends of the primaries are connected together to give one primary terminal, the outside ends to give the other. The terminal of the main coil nearest the primaries is connected to the filament (grounded) side of the circuit to reduce capacity effects, exactly as is done in ordinary r.f. transformer practice.

In answer to a query requesting the size primary to use for screen-grid tube work it is recommended that the primary-secondary transformer method of coupling *not* be used; rather, that the impedance method be employed, which method requires only one ordinary torusolenoid coil. Francis Churchill gives this circuit in his story on shield-grid tubes for the "Hi-Q" receiver on page 28, January, 1928, RADIO. It can be said with utter truthfulness that the attributes of the torusolenoid make it unqualifiedly the best coil for use with shield-grid tubes.

HARRY R. LUBCKE.

June 8, 1928.

Sir: I read with interest an article in the May issue of RADIO describing a toroid coil which had just been invented by a Professor Ross Gunn of Yale. This coil was referred to in the article as "the greatest improvement in coil construction in the history of modern radio." Unless I have misconstrued the description of the coil in question, the invention appears to be completely anticipated and disclosed in German patent No. 309,211 of September, 1919.

I am calling this to your attention because I know that it always has been the policy of RADIO to print only authentic information.

T. R. GOLDSBOROUGH,
Patent Department,
Westinghouse Elec. & Mfg. Co.

An Appreciated Bouquet

Sir: Some time ago I happened to pick up a copy of RADIO on a news stand, and looked through the table of contents. I bought that copy, the May number, by the way, and I wish to say that for covering radio from one end of the field to the other, RADIO is the best little magazine that I have ever had the fortune to meet.

Your advertisements cover as much if not more ground than I have ever seen in any one periodical; your "Radiotorial Comment" is worth the price of the magazine, by itself; the separate departments seem to be so deep

(Continued on Page 49)

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A richly embossed oxidized bronze escutcheon of exclusive design and graceful proportions.

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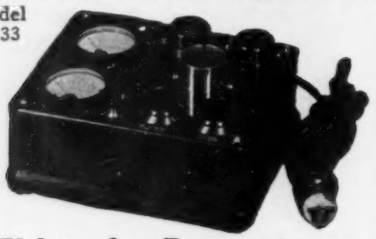
COUNTER
TUBE CHECKER

Model 533



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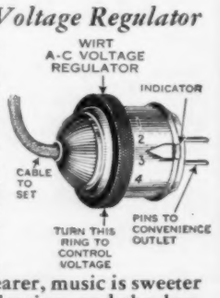
A-C tubes, filters and step-down transformers are built to operate on 110 volts. In *many* places the normal line voltage is from 112 to 118 volts. In *most* places the voltage varies, so that sometime during day or night there are "surges" which burn out tubes and harm sets.

Wirt A-C Voltage Regulator

protects set and tubes, eliminates extraneous line noises and thus improves the tonal quality of your set. The speaking voice comes in truer and clearer, music is sweeter and more pleasing, and the harmony perfectly balanced.



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THE WIRT COMPANY
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INTERFERENCE BLOODHOUND

(Continued from Page 21)

and a jack mounted in the end of the dowel, the whole thing was easily demountable. Connection to the set was made by a 6-ft. loud speaker cord. The capacity between the leads did not seem to materially affect the tuning of the loop circuit.

An old Radiola "semi-portable" panel was built into a specially made oak carrying case. This set carried a filament voltmeter to provide a check on the filament circuit in order that accurate measurements of signal intensity could be made.

The visible indicator and all batteries were built into a small carrying case.

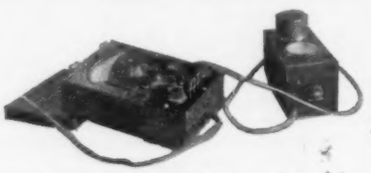

Fig. 1. Visible Indicator of Radio Interference

The indicator consisted of an extra audio stage with a milliammeter connected in the plate circuit in place of a loud speaker, as shown in the picture Fig. 1. This is connected directly to the output of the set, and, as will be noted from the accompanying diagram, Fig. 2, a high voltage *C* battery is used.

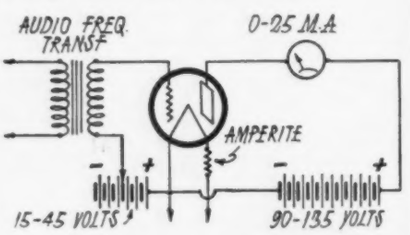

Fig. 2 Diagram of Vacuum Tube Voltmeter

The unit works as follows: The tube in the amplifier will draw a certain amount of current whether there is a signal or not. Increase the bias battery until there is no current flowing when there is no signal. Upon reaching this point it will be found that the reading on the meter scale will be proportional to the strength of the signal. To prove this, tune in some sound with the loop turned broadside towards it. Slowly rotate the loop until it points at the source of interference and note the amount of increase. This really is a mild form of a vacuum tube voltmeter, one of the most sensitive instruments known.

An interesting experiment may be made by shunting a loud speaker directly across the primary winding of the input transformer of the indicator stage. This permits hearing as well as seeing the signal and is an invaluable aid in preliminary trouble shooting work. After

A New
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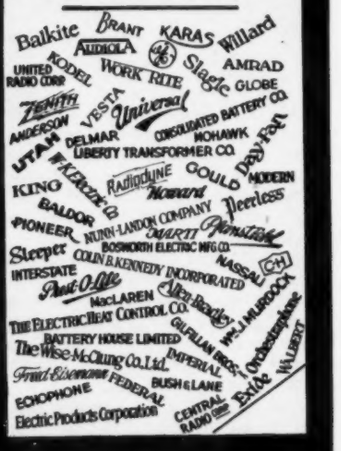

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having made a few tests with the speaker left plugged in you will believe what has been said regarding the human ear. It must be remembered at all times during the operation of this equipment that a constant filament voltage must be maintained, otherwise a varying plate current will result, producing a fluctuation of meter readings that will defeat the whole purpose of the test.

A word about the set in operation may not be amiss. This is best accomplished by recounting an actual incident that occurred. The power company men were trying to locate a "leak" that was causing a lot of noise in a nearby radio set. The loop on the car pointed toward a power line some 200 ft. away. The men had been riding all over the territory, but wherever they went the buzz sounded just as loud in their head set. The trouble car was brought into use. All bearings taken indicated that the source in interference was in a certain block. Starting at the corner, the car was driven slowly down the street with the speaker left plugged in. Within 5 ft. of a certain pole the reading on the meter began to climb. Directly opposite it doubled. A couple of yards beyond it dropped back to normal. However, there was one thing that could not be overlooked. During all this time the audible strength of the signal had not increased enough to notice, which goes to show that you never can tell without something to look at. From the above description and the accompanying diagram the reader can plan his own outfit. Should there be anything that has not been clearly brought out more detailed information will gladly be given upon receipt of a letter addressed to the writer, care of this magazine.

LETTERS TO THE EDITOR

(Continued from Page 47)

into the radio game that they have passed the stage of turning back, and your department, "The Commercial Brasspounder," is a godsend to the members of the radio fraternity, who, like myself, have to depend a good deal upon such publications, to keep ourselves abreast of the numerous developments that are always being made by the "game" in general.

If you happen to have a bit of space in one of the future issues, please give the boys the following dope on XDA. Many of the intercoastal operators seem to be lacking sadly in information concerning this station.

XDA, Mexico City, broadcasts time and weather at 11:00 a. m. and 5:00 p. m., Pacific Standard Time, on a wave of about 2700 meters, C. W. His weather report consists of numerical code observations from 18 Mexican cities, followed by forecasts for eight zones, as follow: West Gulf of Mexico, north and south portions: Coast of Yucatan, West Coast of Lower California, Gulf of California, north and south portions; South Pacific Coast of Mexico, Gulf of Tehuantepec.

The forecasts are sent in Spanish, and a short acquaintance with them makes it easy to translate into English. Immediately after the XDA, QST, XAE, Mazatlan, rebroad-

(Continued on Page 50)

Be Your Own Broadcaster

The Sky Is the Limit

A New Idea for a Radio Party!

The mystic Home Broadcaster is attached to any radio set in a jiffy. No skill required. Stretch long extension cord into another room or closet, press the switch button on the microphone which automatically cuts off radio reception and you begin to broadcast.

Then the Fun Begins!

Sing—Joke—Play—The sky is the limit! Release the button and radio reception comes through once more. Slip a Home Broadcaster in your pocket when you go to the next radio party and see what happens. It is not necessary to remove the Broadcaster from the Set. It can be left permanently connected to the Set as it will not interfere with radio reception. The Broadcaster is therefore always ready for instant use.

Send No Money!

Pay postman $4.95 plus postage for the Home Broadcaster outfit consisting of Microphone, Special extension cord and adaptor plug. State whether you want the Type U. X., using 4-prong detector tubes or Type A. C., using 5-prong detector tubes. If you are not entirely satisfied your money will be returned.

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AIR LINER CALL LETTERS

(Continued from Page 33)

of the dirigible balloon type and is attached to the French Navy, special calls are assigned, as is the case with dirigibles having names. The French planes occupy the greatest amount of space in this new list, all machines on all air routes as well as army and navy ships which are radio-equipped being mentioned. The general call for French aircraft is FOZ.

British flying boats and land planes on the air lines and with the Royal Air Force are also mentioned, the letters all starting with G, such as GEBAJ. All Royal Air Force machines can be called by the call of GEZAA, used as a general signal.

Since most of the Dutch planes listed are equipped for radio-telephony, it is best to explain how such ships can be called. When using voice the procedure is to make a call using the whole or part of the name of the owner, followed by the last two letters of the registration mark. The airplane H-NACR, its registration mark, uses telephony. Its radio call is therefore KLMCR, the KLM being the first three letters of the air company name.

Italian ships are again otherwise designated on the air. For registration they use the five-letter system starting with I and follow this with a numeral. For this reason the radio calls are all specially assigned, and the Italian plane I-AYZZ 70 has as its radio call IXAAG.

The United States is only credited with two call letters in this list, which is the latest, issued in February. The two calls are those of the Los Angeles, NERM, a special navy call, and the ill-fated Dawn, call WMU, again a special call.

The Berne List, which is to be found on every steamer and at every coast station throughout the world, is already a thick book. It lists all steamers, warships and coast station calls. When the aircraft calls are added it will be a much bigger list. France so far heads the nations with its aircraft radio calls, there being over 90 calls.

Most of the planes use the long wavelength, varying from 600 to 1550 meters, with 900 meters as the stand-by for watches. With the exception of French navy balloons, all the planes use continuous wave transmission or telephony. These few dirigibles use spark.

LETTERS TO THE EDITOR

(Continued from Page 49)

casts the Pacific Coast forecast, followed by like service from XAK, Acapulco, and XAN, Salina Cruz. This service is useful on the entire run from Los Angeles to Balboa.

I am enclosing my subscription for the next six issues of RADIO, and if they are as good as the May issue, I am expecting a real treat.

Sincerely yours,

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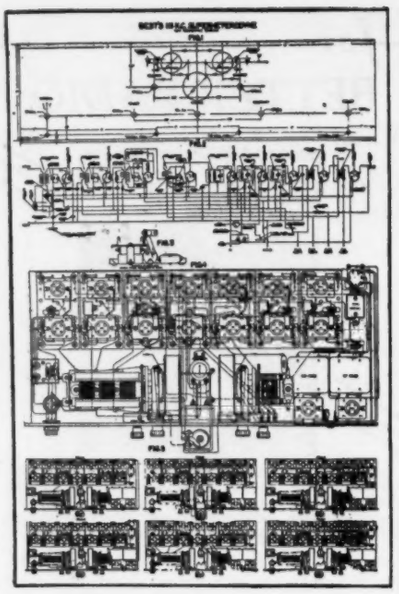

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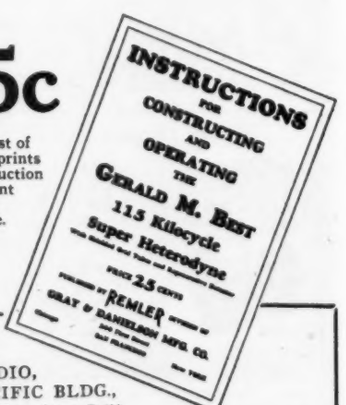

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RADIO KIT REVIEWS

(Continued from Page 36)

Fig. 2 shows the type of filament circuit and grid return found in the usual receiver. Remembering that the tube input circuit is completed from the "grid return" wire to the filament circuit, thence to the filament itself, and across the filament-to-grid capacity back to the grid, it will be seen from the diagram that there are two paths for such a current to follow.

One is in accordance with common conception, up through the short side, through the rheostat or fixed resistor, to the filament. The other is through the long *A* battery leads to the other side of the filament. Ohm's law states that the current will travel both paths, dividing inversely according to the resistance

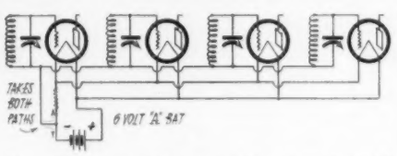

Fig. 2. Usual Filament Circuit and Grid Return

of each. Investigation reveals that in many cases most of the current actually takes what seems to be the longer path,—that through the battery. This is usually due to a resistance in the negative filament lead to furnish a bias for the grids. The resistance drives the current around the other way, furnishing from 5 to 10 ft. of wire common to all circuits. The impedance of this wire to radio frequency currents gives a strong common coupling to them all.

Various methods were tried to eliminate common coupling, the circuit shown in Fig. 3 finally being selected as the method that best eliminated this trouble. Note that both sides of the r.f. filaments are bypassed directly to ground through 1 mfd. condensers and in order to eliminate common coupling in the leads individual wires are run from each tube directly to the bypasses.

Another unsuspected source of feedback and common coupling was found in shielding and chassis when used as an r.f. return from coil to condenser. It has been usual to ground to the shielding wherever possible, using it as a return circuit instead of running wires. This is good practice for battery returns but is all wrong from a radio frequency standpoint. Fig. 4 clearly illustrates this point.

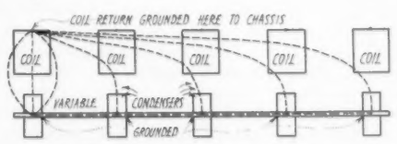

Fig. 4. Effect of Using Shield as Return Circuit

The dotted lines show the spreading out of the radio frequency current from the "grounded" end of the coil to the condenser. These currents spread to the limits of the shield in every direction and thus part of the current from the first coil flows right under, and in the same return circuit as that of the second, third and fourth coils, directly inducing voltage into them through the common shield impedance (which is plenty) and ruining the selectivity of the receiver. Individual wires from coil to condenser frame will eliminate this completely.

These are only a few of the difficulties encountered in designing the Sargent-Rayment Seven, but they serve to illustrate the problems encountered. Feedbacks and couplings which

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in a five-tube set of two years ago would be utterly negligible become of first magnitude on account of the tremendous amount of amplification of the receiver. The greater the amplification, the less the amount of coupling needed to cause oscillation,—thus design and layout are of primary importance,—more so than the circuit used.

Mention of 10 kilocycle selectivity may raise the question as to whether tone quality suffers in proportion and whether there is any cutting of side bands. The writer believes "cutting of the side bands" in a radio receiver to be a myth. Not that there is any denial as to the presence of side bands when two frequencies are mixed! Their presence has been proven both mathematically and in practice, but it has never been shown that they are necessary to perfect reproduction of music.

In the opinion of the writer, there has never been a set built with enough non-regenerative selectivity to accurately test this question. Distortion of tone in a sharp receiver which is blamed on side band cutting, always occurs in a highly regenerative circuit, and is caused not by too sharp a cut-off, but by a heavy overload on the peak. The loud notes, heavily modulated, carry extra power which overloads the regenerative tubes, causing a rattle and crackle, while the weaker notes do not do so.

It must be remembered that radio broadcasting is done by a modulation of the power or amplitude of the transmitted wave, and obviously any receiver sharply tuned to the wave will receive all of these power modulations and there will be no distortion provided no tubes are overloaded. Proof that most transmission actually takes place in this way is furnished by the well known fact that except under the heaviest modulation, there is no fluctuation in the beat note of a local station when received on an oscillating set. However, "the proof of the pudding is in the eating," and competent witnesses who have heard the performance of the set that is here under discussion state that, despite the 10 kilocycle selectivity, there is no distortion of tone.

A Good Soldering Hint

By O. R. VOPEL

A "cold" soldering iron that makes a "hot" connection can be made from an old electric soldering iron, whose element and tip has been removed. Insert a carbon from an old flashlight battery so as to fit tight. The tip may be filed to suit the fancy. Twist both bare ends of wire together and fasten to the pipe which contained the electric element with a small machine screw. Twist both bare ends of wire on other end of extension together and fasten to a battery clip. All extra that is needed is another piece of wire with two clips.

Do not hold iron on spot to be soldered, but as near as possible and only long enough to allow solder to flow freely. A little practice will put you wise.

That picture transmission will soon be an interesting feature of radio broadcasting is quite certain. Several Eastern stations are already in the field and it is reported that about 150 stations have applied for transmitting apparatus. As far as results are concerned, fairly good pictures have been received with amateur apparatus up to distances of 700 miles, although it is readily admitted by those interested in this work that the transmission of pictures is essentially a short range proposition.

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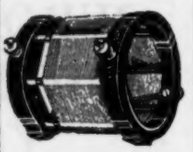

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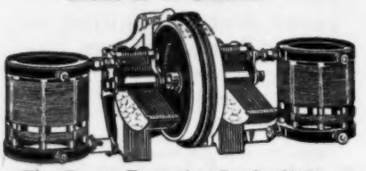

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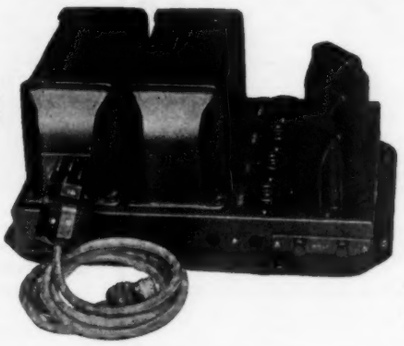

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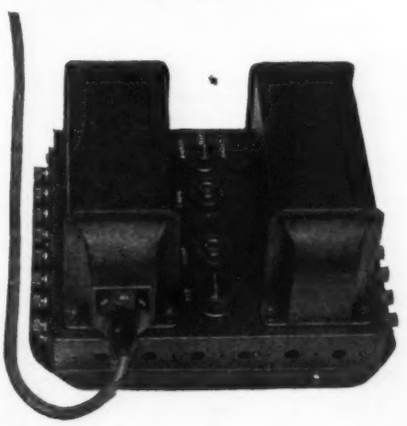

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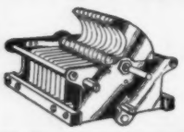

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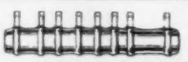

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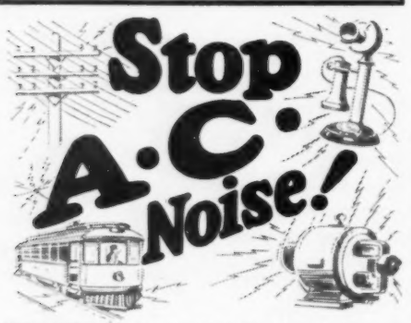

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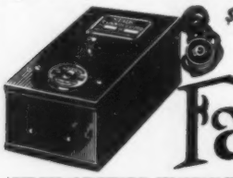

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Measuring Antenna Resistance

By C. HAROLD CAMPBELL
RADIO 1iv

A simple and accurate method of measuring the resistance of an antenna is shown in Fig. 1. The only thing outside of the regular transmitting installation, which may be a 5 or 500 watts in your favorite circuit, is a few feet of resistance wire and a knife switch. It is essential that the d.c. resistance per in. of the wire is known. This may be found from a resistance chart or by measurement.

Close the switch, shunting the resistance, and tune the antenna to resonance at the highest wave that readings are to be taken. Note the current shown by the antenna ammeter. Open the switch and vary the amount of resistance using the clip until the antenna current falls to exactly one-half its former value. It is evident that the antenna system must have twice as much resistance as when the switch was closed and by measuring the length of the resistance wire between *A* and *B*, the antenna resistance can be found.

Lower the wavelength by cutting out some of the antenna inductance and take another measurement. Do this at various wavelengths a few meters apart and plot the curve on graph paper. It is important that the resistance wire is stretched out in a straight line or nearly so in order to be non-inductive.

The resistance curve of the antenna at 1iv is shown in Fig. 2.

When the resistance of an antenna system is known, the power output may be calculated from the formula $W = I^2 R$; W = watts output. I, the antenna current and R the resistance of the antenna at that particular wavelength.

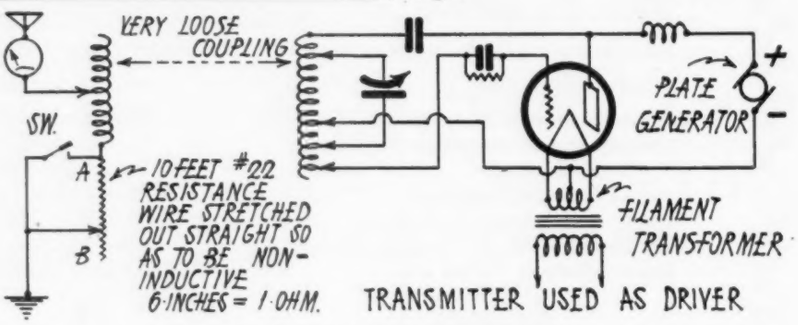

Fig. 1. Method of Measuring Antenna Resistance

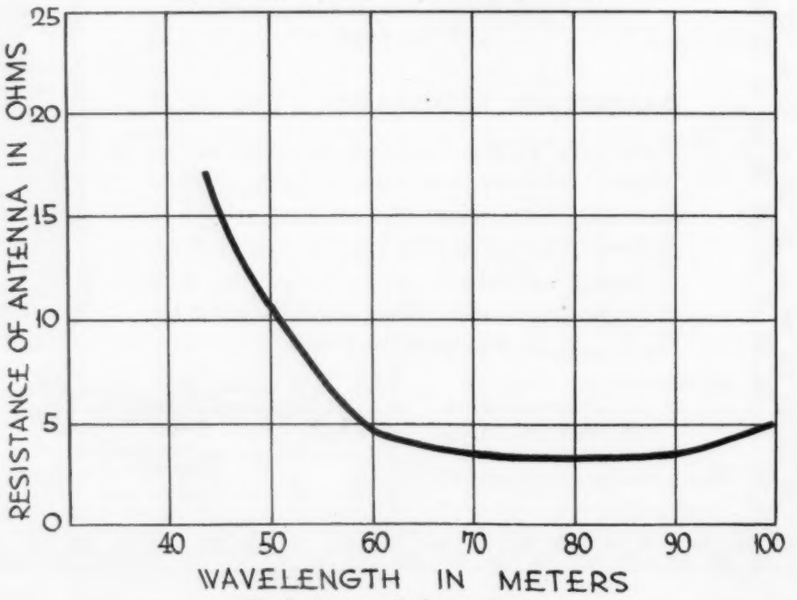

Fig. 2. Antenna Resistance Curve

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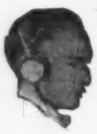
18 Webster St., Haverhill, Mass.

$1597 In Five Months



"The N. R. I. is the best Radio school in the U. S. A. I have made $1597 in five months. I shall always tell my friends that I owe my success to you."
HENRY J. NICKS, Jr.,
302 Safford Ave.,
Tarpon Springs, Fla.

$1164 Spare Time Profits

"Look at what I have made since I enrolled, $1,164—money I would not have had otherwise. I am certainly glad I took up Radio with N. R. I. I am more than satisfied."
HENRY R. HEIKKINEN,
123 W. Erie St., Chicago, Ill.

Over $1000 In Four Months

"My opinion of the N. R. I. course is that it is the best to be had at any price. When I enrolled I didn't know a condenser from a transformer, but from December to April I made well over $1000 and I only worked in the mornings."
AL. JOHNSON,
1409 Shelby St., Sandusky, Ohio.

I will show you too how to start a spare time or full time Radio Business of Your Own without capital

Radio's amazing growth is making many big jobs. The world-wide use of receiving sets and the lack of trained men to sell, install and service them has opened many splendid chances for spare time and full time businesses.

Ever so often a new business is started in this country. We have seen how the growth of the automobile industry, electricity and others made men rich. Now Radio is doing the same thing. Its growth has already made many men rich and will make more wealthy in the future. Surely you are not going to pass up this wonderful chance for success.

More Trained Radio Men Needed

A famous Radio expert says there are four good jobs for every man trained to hold them. Radio has grown so fast that it simply has not got the number of trained men it needs. Every year there are hundreds of fine jobs among its many branches such as broadcasting stations, Radio factories, jobbers, dealers, on board ship, commercial land stations, and many others. Many of the six to ten million receiving sets now in use are only 25% to 40% efficient. This has made your big chance for a spare time or full time business of your own selling, installing, repairing sets.

So Many Opportunities You Can Make Extra Money While Learning

Many of our students make $10, $20, $30 a week extra while learning. I'll show you the plans and ideas that have proved successful for them—show you how to begin making extra money shortly after you enroll. G. W. Page, 1807-21st Ave., S., Nashville, Tenn., made $935 in his spare time while taking my course.

I Give You Practical Radio Experience With My Course

My course is not just theory. My method gives you practical Radio experience—you learn the "how" and "why" of practically every type of Radio set made. This gives you confidence to tackle any Radio problems and shows up in your pay envelope too.

I Will Train You At Home In Your Spare Time

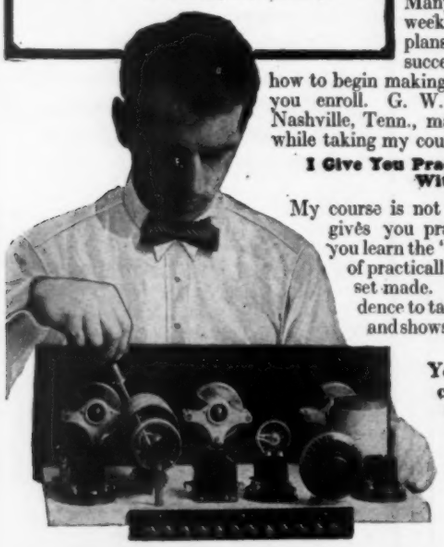
I bring my training to you. Hold your job. Give me only part of your spare time. You don't have to be a college or high school graduate. Many of my graduates now making big money in Radio didn't even finish the grades. Boys 14, 15 years old and men up to 60 have finished my course successfully.

You Must Be Satisfied

I will give you a written agreement the day you enroll to refund your money if you are not satisfied with the lessons and instruction service when you complete the course. You are the only judge. The resources of the N. R. I. Pioneer and Largest Home-Study Radio school in the world stand back of this agreement.

Get My Book

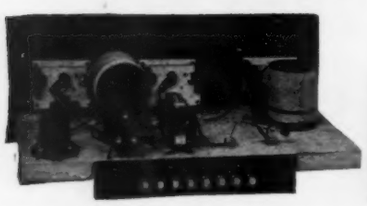
Find out what Radio offers you. My 64-page book, "Rich Rewards in Radio" points out the money making opportunities the growth of Radio has made for you. Clip the coupon. Send it to me. You won't be obligated in the least.

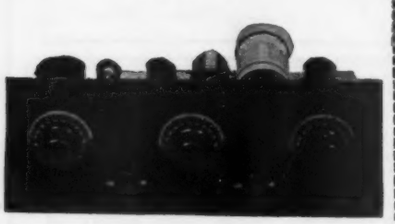


You can build 100 circuits with the Six Big Outfits of Radio parts I give you. The pictures here show only three of them. My book explains my method of giving practical training at home. Get your copy!

Address

J. E. Smith, Pres.
Dept. 8 R
National Radio Institute
Washington, D. C.





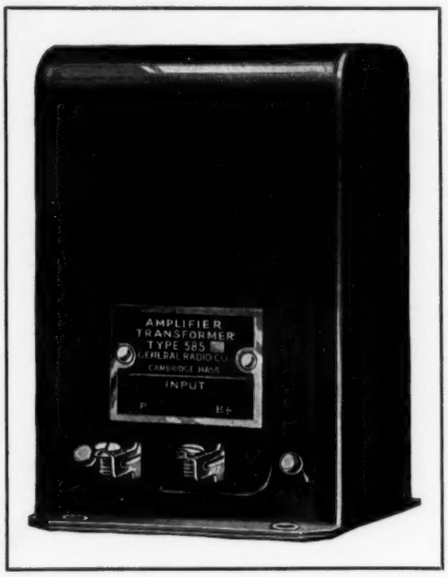
This coupon is good for a FREE copy of my Valuable Book. Mail it NOW!

J. E. Smith,
President,
Dept., 8R
National Radio Institute, Washington, D. C.

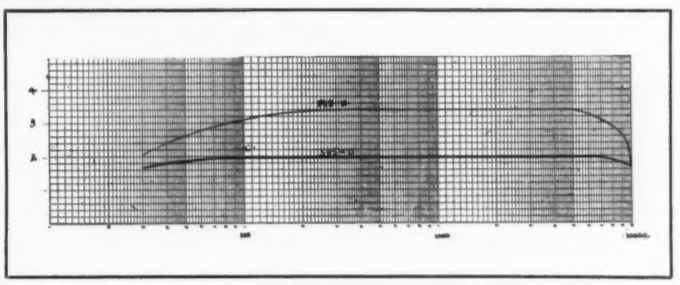
Dear Mr. Smith: Send me your book. I want to know more about the opportunities in Radio and your practical method of teaching at home in spare time. This request does not obligate me to enroll and I understand no agent will call on me.

Name.....Age.....
Address.....
City.....State.....

THE GENERAL RADIO
TYPE 585
HIGH QUALITY AMPLIFIER TRANSFORMER



THE General Radio Company announces a new group of high quality amplifier transformers at a direct to the consumer price. This new group consists of two instruments, the Type 585-D and the Type 585-H, the amplifications characteristics of which are shown below. A new line of high quality push-pull input and output transformers is also available for the experimenter.



Specifications:

TYPE 585D	TYPE 585H
Pri. Inductance: 79H	Pri. Inductance: 71H
D.C.R. Primary: 2000 ohms	D.C.R. Primary: 2000 ohms
Sec. Inductance: 316H	Sec. Inductance: 866H
D.C.R. Secondary: 9300 ohms	D.C.R. Secondary: 11000 ohms
Turns Ratio: 1:2	Turns Ratio: 1:3.5

GENERAL RADIO Co

New Prices. Write for new catalog No. 930, listing new low prices on all General Radio apparatus on a direct to consumer basis.

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A Marvelous New Receiver by Browning-Drake

The Model 32 Console

BROWNING-DRAKE laboratories are presenting for this season one of the most remarkable receivers yet demonstrated to the trade. In performance it accords with the highest engineering standards. In beauty it is a revelation and in freedom from service care it is a source of joy to every dealer.

Other models, manufactured to the same high standards, make up a complete line your dealer is proud to handle.

The new Browning-Drake loud speaker, licensed under the Whitmore (Air-Chrome) patent, has impressed experts as has no other for years past. Be sure to hear one at the earliest opportunity.

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